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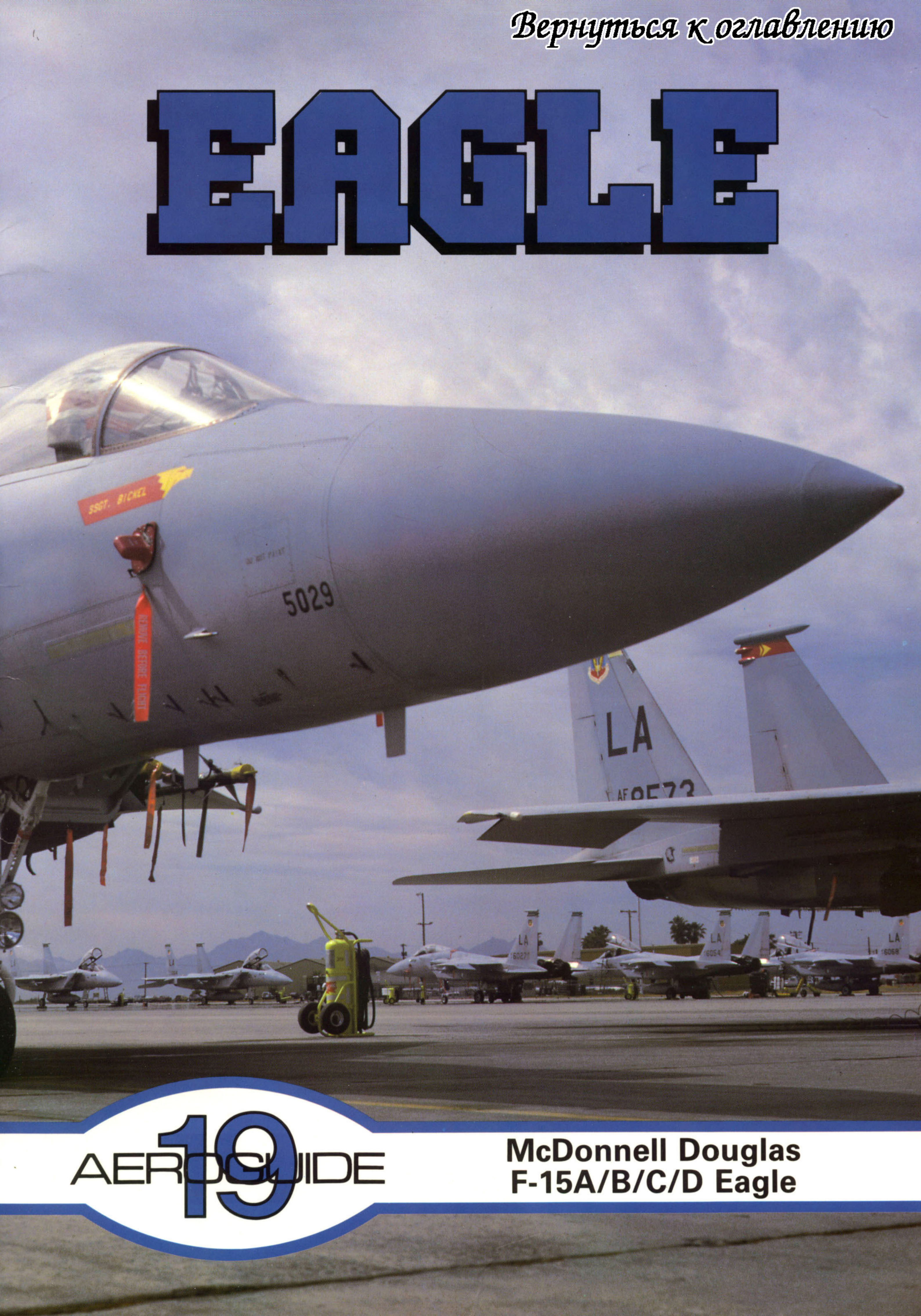
EAGLE



AEROGUIDE 19

McDonnell Douglas
F-15A/B/C/D Eagle

AEROGUIDE 19:
McDONNELL DOUGLAS F-15A/B/C/D EAGLE

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Written, designed and produced by Roger Chesneau
Colour profile and line drawings by Mike Keep
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Cover photo: F-15 Eagles of the 405th Tactical Training Wing's 426th and (background) 555th Tactical Fighter Squadrons, Luke Air Force Base, 1985.

Back cover plate: An F-15A of the 318th Fighter Interception Squadron, based at McChord AFB, 1983.

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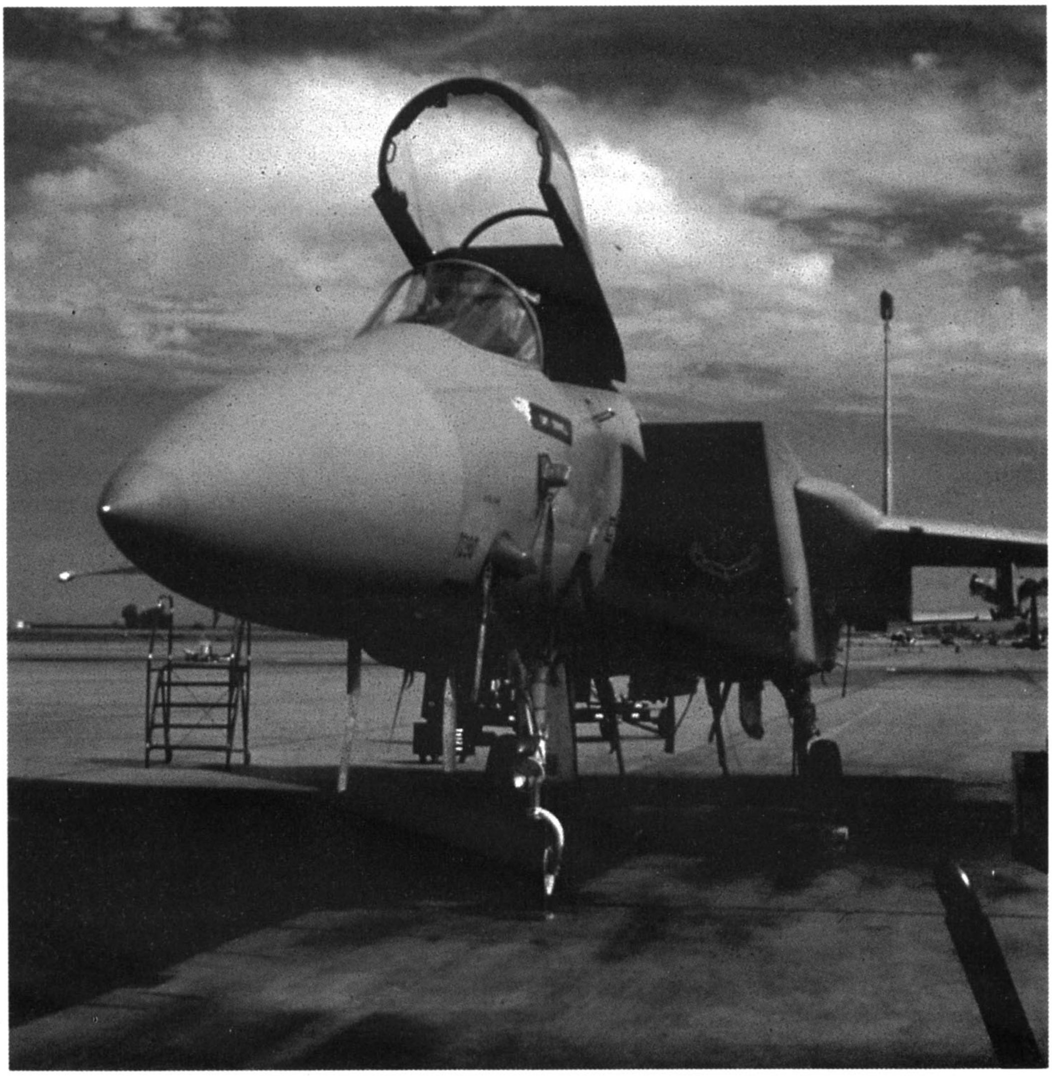

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INTRODUCTION

On 9 July 1967 the Western world received a nasty surprise. At Domodedovo, near Moscow, the Soviet Union revealed two brand new aircraft. One was a variable-geometry fighter aircraft rather larger than the MiG-21; the other was a massive, twin-finned interceptor with gigantic engines and obviously capable of very high speeds. The first aircraft, dubbed 'Flogger' by NATO and later identified as the MiG-23, was clearly a potent machine and one that would have to be taken very seriously indeed if, as anticipated, it entered quantity production for Soviet service, but the second aircraft, code-named 'Foxbat', caused nothing short of consternation. Hints of something rather special in the Soviet armoury had come along two years previously when an aircraft referred to as the Ye-266 had claimed a 1000km closed-circuit world speed record of 1441.5mph with a 2000kg payload; confirmation of the West's fears came in October 1967 when the Ye-266 recorded a 500km closed-circuit speed of 1852.61mph.

The Ye-266 (or MiG-25, as it became known) was probably developed in order to counter the threat posed by the US Air Force's B-70 Valkyrie Mach 3 strategic bomber, which first flew in September 1964, and Western anxieties began to be heightened as it became clear that the Soviet programme was continuing, despite the fact that the US bomber was cancelled soon afterwards: for the first time since World War II it began to look as though, in the event of conflict, US air superiority would by no means be assured. A programme designated FX (for Fighter Experimental) was already in train, but it had been proceeding at a relaxed pace because the need to control the skies had, in the strategists' minds, been deemed less important than short-range, point-defence interception or tactical attack, for which diverse tasks all US fighters of the late 1950s and early 1960s had been optimised.

With the revelations at Domodedovo the FX project received an unexpected fillip, and the original Request for Proposals, issued to the defence industry by the US Air Force late in 1965, were very smartly edited to include reference to a top speed of Mach 3, the ability of the aircraft to carry out ground attack sorties being deliberately played down. The RFP required studies only – this was still the era of 'total package procurement', and there was never much chance of competing prototypes being built – and contracts to carry out these studies were awarded to General Dynamics and McDonnell Douglas, several other companies continuing the work supported by in-house funding. From the submissions received the US Air Force awarded project definition contracts to McDonnell Douglas, Fairchild and North American in December 1968, by which time the basic configuration of the new aircraft had been settled. A one-man crew was specified, partly as a weight-saving measure but also, probably, to keep the project as different as possible from the Navy's two-man VFX (later to be produced as the F-14 Tomcat), which the Air Force did not wish to have imposed on it as a cost-saving substitute; a normal gross weight of 40,000lb was to be taken as a design parameter; twin engines, the combined afterburning thrust of which would exceed the normal gross weight of the aircraft, would be required to produce the necessary power; and, after some hesitation, a fixed wing was settled on, emphasising the single role which would be the aircraft's function. In late 1969 McDonnell Douglas was informed that its proposal for FX had been accepted, and the victory was confirmed with a contract for the company to build twenty aircraft.

Below: The FX programme was one of the most adventurous in US Air Force history, and would result in a very formidable aircraft, the F-15 Eagle.

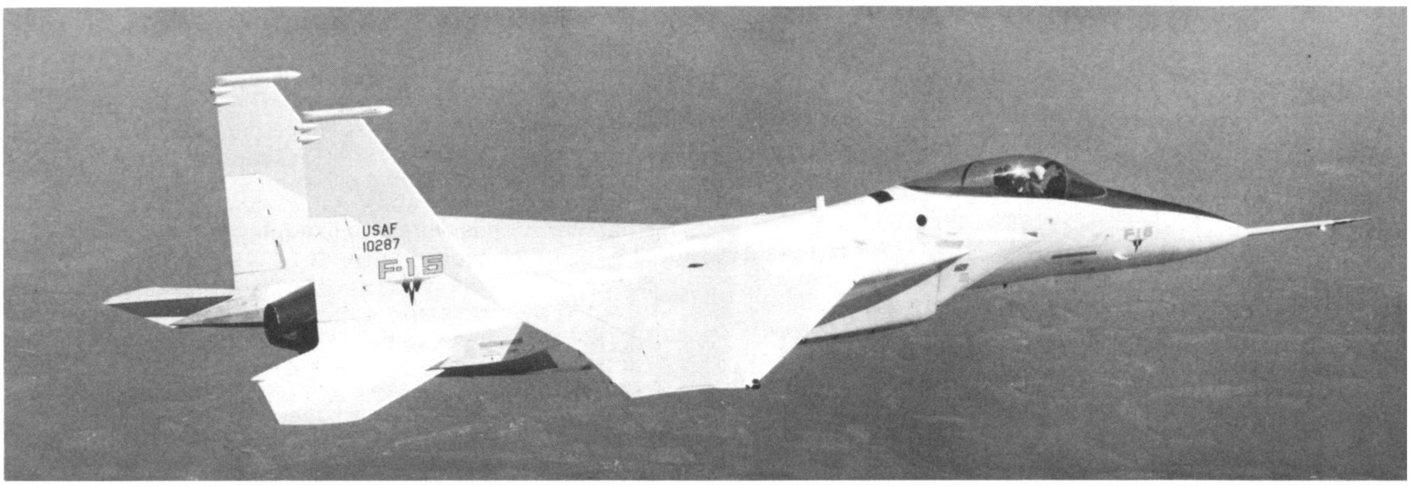
Right: An F-15A of Alaskan Air Command climbs vertically against an Arctic backdrop. It carries its full armoury of four medium-range Sparrow AAMs and four Sidewinder AAMs for close-range engagements. In this configuration, the thrust from the two engines exceeds the aircraft's weight. *McDonnell Douglas*

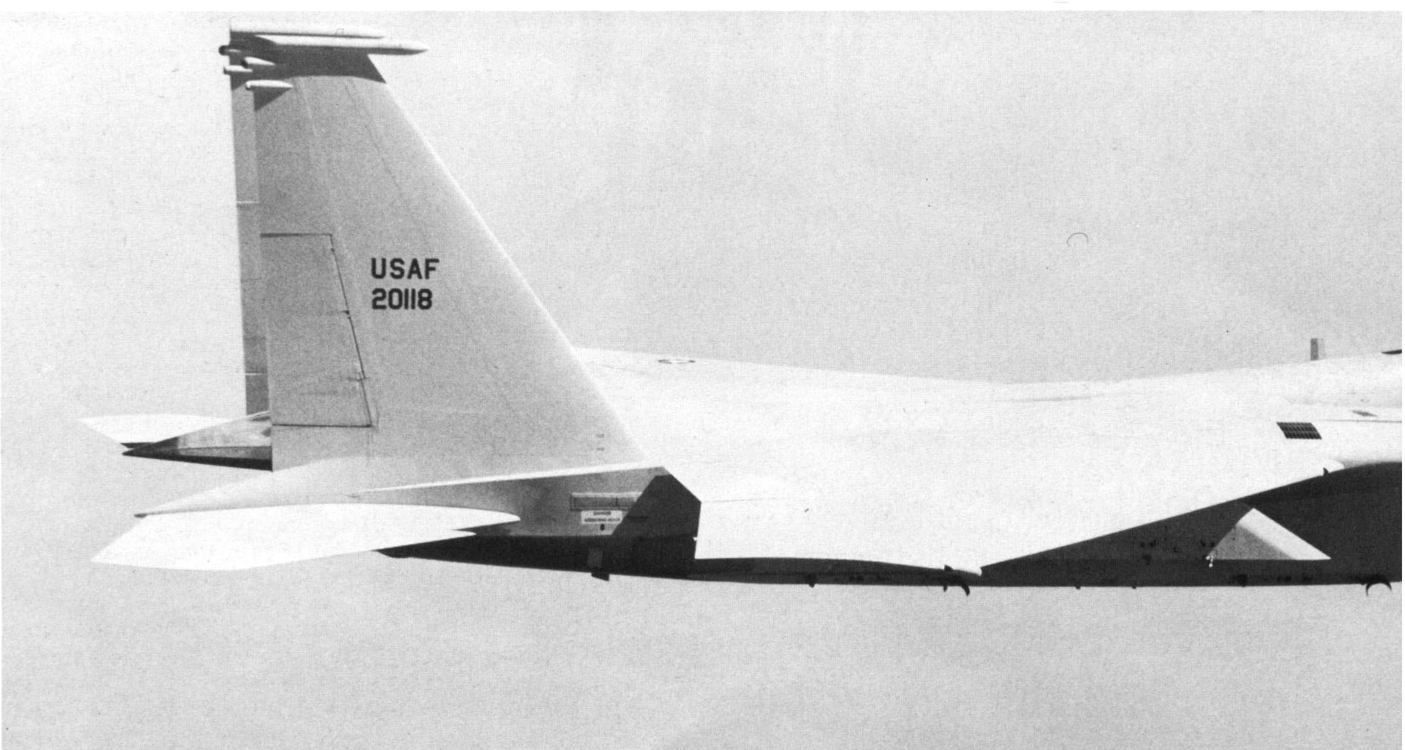

AK

DESIGN & DEVELOPMENT

The FX competition, once under way in earnest following the shocks of the 1967 Domodedovo Air Show, produced an enormous amount of paperwork, with masses of words, statistics, graphs, mathematical calculations, design diagrams and artist's impressions, plus a large number of models, demonstration, mock-up and wind tunnel, but, at first, no actual flyable hardware. The reason for the weighty theoretical submissions is not difficult to appreciate: if one picture speaks a thousand words, one full-scale aeroplane must account for at least a million. The absence from the programme of a demonstrable prototype – in other words, the pursuit of the 'total package procurement' policy – could be explained, in the main, by the vast expense involved in the production of such an aircraft, although another reason was the additional delays implied by prototype construction (and evaluation), which militated against the urgency with which the FX project was now being treated. TPP had first been applied to the TFX (F-111) and C-5 Galaxy programmes, but the system, which was in full swing when the FX got going in 1967, was not fulfilling its early promise as the practicalities of turning paperwork into hardware within the estimated cost and time limits proved more than difficult.

McDonnell Douglas' initial twenty-aircraft contract – which was split into two equal batches, ten company trials and development machines and ten for full-scale development (FSD) – was, as a result, subjected to especially rigorous scrutiny regarding its costing, and the development work was laid out as a series of carefully structured stages, each of which had to be met in full by the contractor before any funds could be released for future work. The reasoning for this procedure is apparent, and it did much to assure the financial stability of the FX project during its formative years, although, as some commentators wryly observed at the time, quite what would have happened to the project had these interim goals not been met is not clear: if funding were to be withdrawn at any time there would be a real problem – there was no alternative aircraft except the F-14, which the





Above: The capabilities of the new fighter were amply demonstrated when a specially stripped-down F-15 established a number of time-to-height world records. Seen here on the ramp outside McDonnell Douglas' St Louis assembly hall, *Streak Eagle*, as it was dubbed, was left in bare metal finish for the record attempts (see page 32) but was later sprayed in the standard F-15 paint scheme. The aircraft now resides in the Air Force Museum at Wright-Patterson Air Force Base. *McDonnell Douglas*

Left: The eighth prototype F-15, with instrumentation boom, special logo on the nose and tail and 'dayglo' orange panels painted over the flying surfaces. By the time this aircraft first flew, in August 1973, the wing tips and tailplane had been revised in shape. *McDonnell Douglas*

Below: F-15 72-0118 was a later pre-series aircraft, allocated to the US Air Force's test programme (Category II). In contrast to 71-0287, cannon gas vents are installed above the starboard wing root fairing. *McDonnell Douglas*

Air Force had fought tooth and nail to resist in the first place!

The dimensions of the new machine were influenced by the choice of powerplant, the size, weight and fuel requirements of which were known quantities; the armament that had to be carried – four medium-range AIM-7 Sparrow missiles, four short-range AIM-9 Sidewinder missiles and a gun – whose size, weight and equipment needs were also fixed; the amount of internal fuel needed to enable the aircraft to carry out its missions successfully; room for the cockpit; and enough space for all the electronic equipment that had to go on board. Variable, but nevertheless confined within certain limits, were the size, shape and position of the flying surfaces, main intakes and undercarriage (having regard to the regime in which the FX was expected to fight and the ease with which its systems could be maintained and serviced) and the method by which all the design features were to be brought together.

From the start, however, it was evident that the fuselage had to be bulky, not only to house the two large-diameter engines but also up front, to accommodate a big and powerful multi-mode radar. One upshot of this was that there was plenty of room to house a spacious cockpit, all the necessary black boxes, the three undercarriage bays and a very great deal of fuel, and still, probably, have space left over. This arrangement also suited the sort of flying characteristics demanded of the new aircraft: the wings could be tailored towards a low loading figure (*ie* could be made thin in relation to their surface area), which was vitally important if FX were to have any agility in the air, since the amount of fuel they were required to contain could be proportionately reduced. The relatively good fuel economy of the powerplants was a further contributory factor in conserving space.

Twin engines required either twin intakes or a single giant inlet which would have to be configured so as to enable air to be gulped in huge quantities at the high angles of attack at which the aircraft would often have to be flown. In the case of a single intake, this would inevitably mean putting it somewhere beneath the fuselage, which might compromise other design features since it would need a complex, bifurcated duct. In the final design, twin inlets were adopted, positioned close to the fuselage just forward of the wing leading edge. An advanced system of movable ramps within each intake controlled the speed at which the incoming air met up with the engine compressor faces, and the sharply raked front lips were hinged so that the entire forward intake sections could be pivoted through 15 degrees (4 up, 11 down) to

give optimum flow conditions, especially during take-off and landing.

The wings, shoulder-mounted to offer greater structural strength per unit of weight and to ease access to the engine systems etc, were kept surprisingly simple. The fairly low aspect ratio (*ie* with chord at the root deep in comparison with the span) permitted high-AOA flight with no danger of wing stall, and variable camber was avoided to cut out potential cost and weight problems. Indeed, old-fashioned ailerons were used for roll control, with plain flaps inboard, whilst the leading edges were featureless apart from conical camber towards the tips. The high-AOA requirement also had a direct bearing on the configuration of the tail surfaces. In particular, a considerable fin area had to be worked in, so as to ensure good directional stability when the aircraft was speeding along with its nose pointing upwards. To avoid having to build in an unnecessarily tall fin, which would have had to be of exceptionally broad chord to keep the aspect ratio low, the vertical stabiliser was split into two elements, mounted on faired booms outboard of the engines to give the necessary separation between them. The opportunity of using these booms to carry the horizontal stabilisers – which would control the pitch of the aircraft in flight but also could be deflected differentially to augment the ailerons for roll control – was taken, mounting them low to keep them out of the disturbed air flowing off the wings. The FX mock-up produced by McDonnell Douglas prior to production showed additional vertical fin area beneath the tail booms, but this was dispensed with in the final design.

The choice of powerplant for the FX project was made shortly after McDonnell Douglas had been awarded the contract to proceed with their aircraft, but it had been clear from the start of the competition that there were only two contenders. The high thrust-to-weight ratio demanded of FX ruled out anything other than large and very powerful reheated engines the like of which had not been seen before in US service aircraft. When the FX was first contemplated in the early 1960s the US 'big two' engine manufacturers, Pratt & Whitney and General Electric, each had a promising test engine under development, but it was P&W's JTF16 which seemed to offer the best opportunities. Refined into the JTF22, this plant would become known as the F100 to the US Air force, and would be available in quantity just at the time the new aircraft moved to production status. It was anticipated at the time

Left, top: The second prototype TF-15A Eagle, up from Luke Air Force Base. This particular aircraft must have seen more paint pots than any other in history: it appears in another incarnation in the next photo, two more schemes are depicted on page 20 of this book, and for a time it even wore French Air Force insignia. *US Air Force*

Left, bottom: The same aircraft in 1982, as the Advanced Fighter Capability (AFC) demonstrator, the special logo for which is carried near the top of the tail fins. As in the previous photo, the aircraft is equipped with FAST packs, but it also carries 'iron' bombs as well as Sidewinders on the wing pylons, plus a Pave Tack designator pod on the centreline station. Note that the main intakes have 'nodded' downwards. The TF-15A Eagle was redesignated F-15B early in the programme. *McDonnell Douglas*

that a navalised version of the engine would be adopted for second-generation Tomcats flown by the US Navy, but serious problems caused the programme for this particular powerplant, designated F401, to be terminated. Since the F100 and the F401 were essentially the same design, this had a devastating effect on the production programme and drove up the unit price of the F100 by a considerable sum, since R&D costs had to be spread that much more thickly. It is difficult to avoid the conclusion that this was one of the reasons why the F100 was later adopted for the US Air Force's 'austere' fighter, the F-16 Fighting Falcon (see AEROGUIDE 18).

Assembling the first batch of FX aircraft, by now officially dubbed F-15, got going as soon as the contract had been finalised. It took some two and a half years of work to get the first aircraft, serial number 71-0280, into the air, an event which took place at Edwards Air Force Base, California, on 27 July 1972. Early flight testing was remarkably trouble-free, and the modifications that had to be made for production aircraft were very few indeed. Some tail flutter was experienced, and to cure this the chord of the horizontal stabilisers was lessened inboard, giving a 'dogtooth' to the leading edge; more serious was the buffeting reported by test pilots during certain phases of the flight profile, but again the solution proved to be straightforward – cropping back the wing tips at their trailing edges. The only other airframe modification of any consequence was to enlarge the surface of the speed brake mounted on top of the fuselage and reduce its angle of elevation, to smooth out the landing approach. Handling qualities needed looking at, in particular the forces built into the control column, which were found to be rather heavy, especially when the F-15 was manoeuvring violently. This was found to be a problem even when the control augmentation system (CAS) – developed to ease the force the pilot had to apply to the stick – was in operation. The answer proved to be a different spring and some fine tuning to the control computer linking up the CAS and the back-up hydro-mechanical control system. There were also some problems landing the big fighter, owing mainly to the narrow track of its undercarriage, and in a crosswind the F-15 showed a distinct desire to veer off the runway, but by enabling the aileron/rudder interconnection (necessary during combat manoeuvring) to unlink itself on touchdown and by increasing the lateral control when the stick was being pulled back during the approach, most of the snags were ironed out.

The flight tests continued for a further two and a half years until the official handover of the first production aircraft in November 1974. The F-15 had demonstrated speeds in excess of Mach 2.5 in level flight and an operating ceiling of more than 60,000ft. Engine performance, avionics capabilities, weapons delivery and handling extremes had all been thoroughly evaluated and passed as satisfactory or better, and the usual stalling and spin trials had been successfully conducted. Apart from the minor hitches already referred to, the only cause for anxiety concerned the powerplants, which encountered serious problems. The trials programme for the F100, running concurrently with the flight trials of the aircraft, revealed failures with fan blades and compressor blades and, on one occasion, experienced the virtual disintegration of an entire engine when it was nearing the end of a 150hr running test. The F100 programme was delayed by almost a year, and for a time there were many more airframes completed than pairs of engines to fit in them.

The two two-seater F-15s in the development batch were originally termed TF-15A but subsequently received the designation F-15B. They differed from the basic single-seater only in the provision of the second cockpit, which duplicated the flight controls sited in the front and so enabled the aircraft to function as a trainer; furthermore, the rear cockpit did not displace anything already fitted in the single-seater. From a distance, the only distinguishing feature of the F-15B is its extended canopy. About one in every seven F-15s produced for US service has been a two-seater, each of which is fully mission-capable.

Within a few weeks of the F-15 entering service with the US Air Force, news broke of a spectacular achievement. The nineteenth development aircraft, 72-0119, smashed five time-to-height world records on 16 January 1975, reaching 3000m in 27.57sec, 6000m in 39.33sec, 9000m in 48.86sec, 12,000m in 59.38sec and 15,000m in 77.02sec. A few days later, on 19 January, the 20,000m record was taken, in 122.94sec; on 26 January the Eagle reached 25,000m in 161.02sec; and on 1 February the aircraft zoomed to 30,000m (just under 100,000ft, or about 18½ miles) in 207.8sec. The record-breaking machine was carefully prepared for these attempts, with all non-essential equipment and extraneous matter (even the paintwork) removed, to lighten the airframe as much as possible and reduce its drag still further, the engines specially tuned up and the fuel load kept to the bare minimum. The previous record-holder, incidentally, had been the Mikoyan Ye-266, the Soviet aircraft that had caused all the consternation in the first place.

In 1978 a series of improvements on which McDonnell Douglas designers had been working since before the F-15 first entered service came to fruition, and the modifications were considered significant enough to warrant a change of designation. The F-16C, and its two-seat counterpart the F-15D, introduced some improved avionics but, perhaps more radically, also increased the internal fuel capacity of the aircraft by about 15 per cent, or more than three-quarters of a ton. This was arranged by building in additional tanks in the wing inboard sections and within the forward fuselage, which, as already noted, had spare room in the F-15A. Even more fuel capacity was made available by means of ingenious detachable pallets designed to snuggle beneath the Eagle's wing roots. Aerodynamically shaped, these 'fuel and sensor, tactical' (FAST) packs, as they became known, can each hold a further 5000lb of fuel, but they can alternatively accept a wide range of sensors in the forward compartments, including infra-red (IR), low-light television (LLTV), laser and camera equipment. The performance of the aircraft is said to be hardly affected when the FAST packs are added, and certainly they must cause far less drag than the normal external tanks, but the undercarriage gear of the original design had to be beefed up to cope with the extra weight.

Further development of the two-seater Eagle has resulted in the F-15E, originally dubbed Strike Eagle. This programme got under way as a private venture by

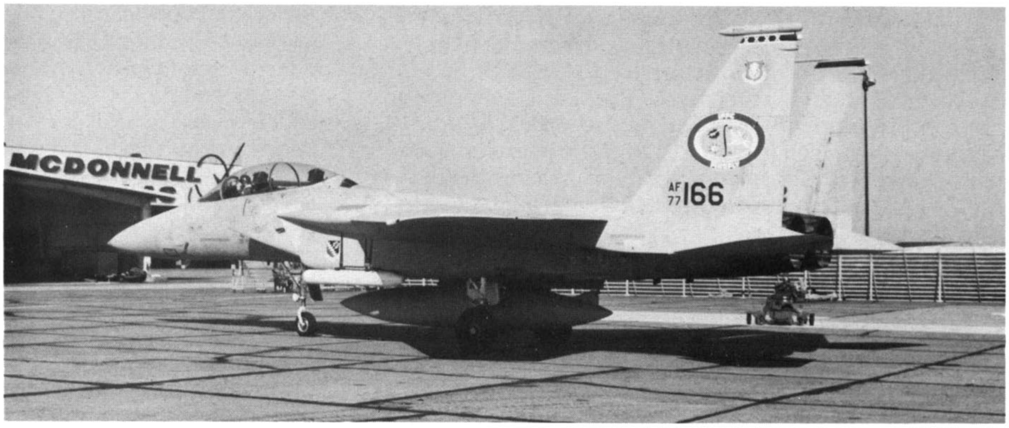
McDonnell Douglas with a view to producing a dual-role aircraft which would complement both the air superiority Eagles and the USAF's F-111 attack aircraft. FAST packs were standard fit, the corners being adapted to carry 'tangentially mounted' stores pylons, and the rear cockpit was redesigned for dedicated weapons systems displays; in addition, extra sensors appropriate to the function of the aircraft, for example forward-looking infra-red (FLIR) and Low-Altitude Navigation and Targeting Infra-Red for Night (LANTIRN) equipment, are fitted. The F-15E was preferred to the F-16XL when the US Air Force decided to go ahead with its Dual-Role Fighter (DRF) programme, and the first prototype (as distinct from the company demonstrator) flew at the end of 1986. About 400 F-15Es are expected to be built, with service entry projected for late 1988.

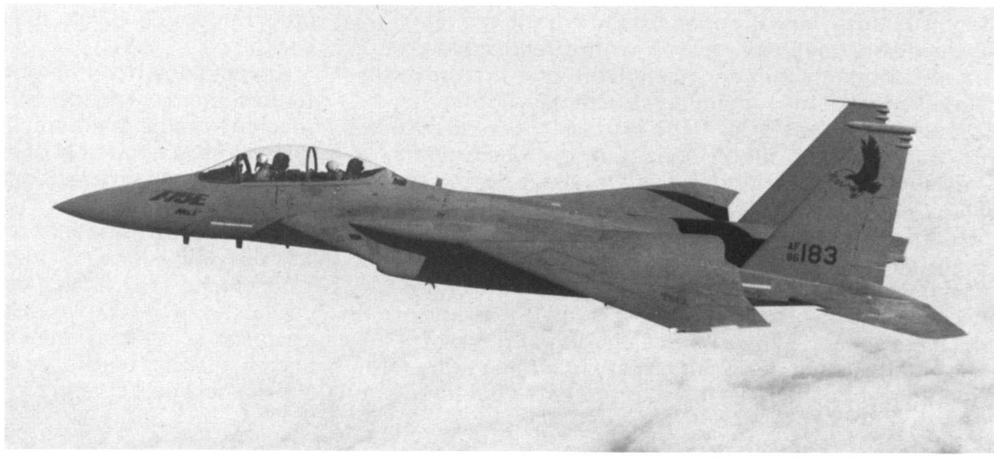
Another very significant F-15-based project is Agile Eagle, a two-seater aircraft much modified to incorporate thrust-vectoring rear nozzles and canard foreplanes. Due to fly for the first time in the spring of 1988, the aircraft is to demonstrate take-off and landing runs in the region of 1000–1500ft, test in-flight, thrust-vectored deceleration techniques and special rough-field undercarriage gear, and incorporate advanced, integrated fly-by-wire (FBW) flight controls. The Pratt & Whitney F100's afterburners will be replaced by quadrilateral-section nozzles (with built in thrust-reversers) able to tilt 20 degrees up or down, giving added manoeuvrability to the aircraft in flight. Agile Eagle will also be pioneering the use of lightweight aluminium-lithium alloys in its construction, notably for the wing panels.

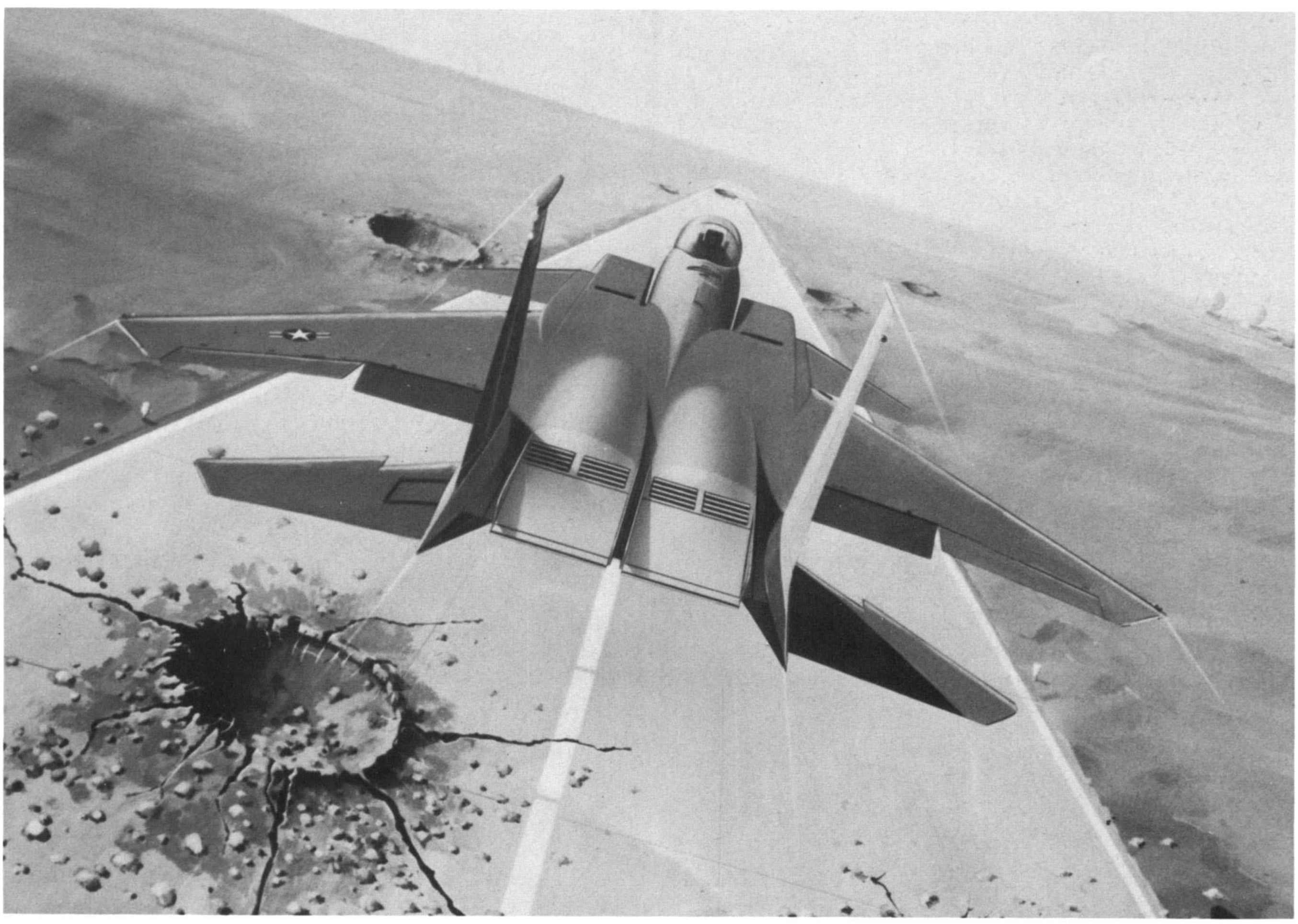
The high unit cost of the F-15 (over $25 million by 1985 according to some unofficial estimates) and the advanced nature of the technology it incorporates have meant that few air forces outside the United States have adopted it – in fact the only three to have done so are those of Japan, Israel and Saudi Arabia. Japanese Eagles, designated F-15J (single-seater) and F-15DJ (dual-seater) are mostly built under licence in Japan by Mitsubishi; one hundred were ordered as a first batch. The Saudi F-15Cs and -Ds, which total 62 in number, are in a constant state of alert because of the proximity of the Persian Gulf war zone, and, indeed, in 1984 a pair of these aircraft shot down two Iranian Phantoms which threatened to penetrate Saudi air space. The Israelis have flown their F-15s into action on numerous occasions, and the potency of the aircraft has been amply demonstrated. In June–August 1982, for example, during the 'Peace for Galilee' offensive in the Lebanon, Israeli F-15s accounted for a considerable number of Syrian aircraft – believed to be over fifty and including a number of MiG-25s – with no loss to themselves.

The F-15 assembly lines at St Louis are expected to be very busy well into the 1990s, with production of the F-15C and -D continuing at a steady pace and the recently announced order for the F-15E expanding the proportion of two-seaters. Some 450 examples of the two early marks have been built, and the US Air Force hopes eventually to receive about 1250 aircraft altogether, inclusive of the -E model. By this time not only will a decision concerning Agile Eagle have been taken (existing airframes could presumably be modified to suit), but the Eagle's projected successor, the Advanced Tactical Fighter (ATF) should also be well into its production schedule. The ATF competition will involve the evaluation of four prototypes, two Lockheed YF-22As and two Northrop YF-23As, and the latter, if successful, will mean that McDonnell Douglas, as Northrop's potential work-sharing partner, could continue its involvement with the US Air Force's front-line fighter force. The ATF contenders are expected to fly in 1989, the choice between the two being made about eighteen months afterwards.

Left: One of the few overseas buyers of Eagles has been the Japanese Air Self-Defence Force, one of whose F-15Js is seen here touching down. Note the high AOA approach, the deflected tailplanes and the extended air brake. *McDonnell Douglas*
Right, above: The Firefly III test-bed Eagle, equipped with an Integrated Flight and Fire Control (IFFC) system and an Automatic Tracking Laser Illumination System (ATLIS) pod to study ways of lining aircraft up automatically with ground targets. *McDonnell Douglas*
Right, below: The F-15E Dual-Role Fighter prototype, serial number 86-0183, first flew in December 1986. A colour photo of the aircraft appears on page 20 of this book. *McDonnell Douglas*
Below: Artist's study of the F-15 STOL Demonstrator (Agile Eagle), which was scheduled to fly in spring 1988. The twin vectoring nozzles will give the F-15 even more manoeuvrability in the air. *McDonnell Douglas*







STRUCTURE

In common with many of today's combat aircraft, the F-15's fuselage has three basic components to its layout – pilot and avionics up front, fuel tanks in the middle, and engines at the back. The centre section also houses the 20mm ammunition for the M61A1 rotary cannon, which itself is carried in the starboard wing root fairing, and on the assembly line incorporates the two huge intake ducts with the main undercarriage bays let into the lower surfaces.

Weight-saving is of course all-important, although the F-15 really belongs to the pre-composites era and so does not make such extensive use of these materials as does, for example, the same manufacturer's AV-8B Harrier II. The principal structural materials are aluminium and titanium. The percentage of the latter is very high compared with other combat aircraft – over 25 by weight, and thus, by virtue of its lower density, rather more than that by volume – and is concentrated around the rear fuselage and inboard wing area, where, respectively, its heat-resistant qualities and its high integral strength are needed. Most of the remaining structure is aluminium, although boron/epoxy skinning is used for the tail surfaces and graphite/epoxy for the construction of the rudders. More specifically, titanium is used for the inboard sections of the three main wing spars, for the wing bearing members within the fuselage centre section and for the rear three fuselage bulkheads. The wing skinning beneath the fuel tanks is also titanium, as is virtually the entire surface of the fuselage wrapping around the engines, which are separated by a vertical titanium firewall.

Components which do not require massive structural strength and do not have to accommodate equipment are generally manufactured from aluminium honeycomb ('Nomex') material. Thus the flaps, ailerons and fixed wing tips utilise this form of construction, and it has also been introduced into the flying surfaces at the tail and in the dorsal air brake as a 'core' material to provide the necessary stiffness. The rest of the F-15's airframe structure is for the most part machined aluminium, which accounts for some two-thirds of the aircraft's empty weight. As usual, specialist materials tailored to the task are incorporated where required, for example glassfibre for the radome (necessary to enable the radar to 'see' through it) and steel for the undercarriage legs and struts and the tail hook (where super strength is obviously called for). The canopy is moulded from acrylic/polycarbonate plastics, as is the one-piece windscreen. The canopy/screen components have a high tolerance of temperature extremes, good resistance to abrasion and require very little framework, giving the pilot a superb view out of the cockpit.

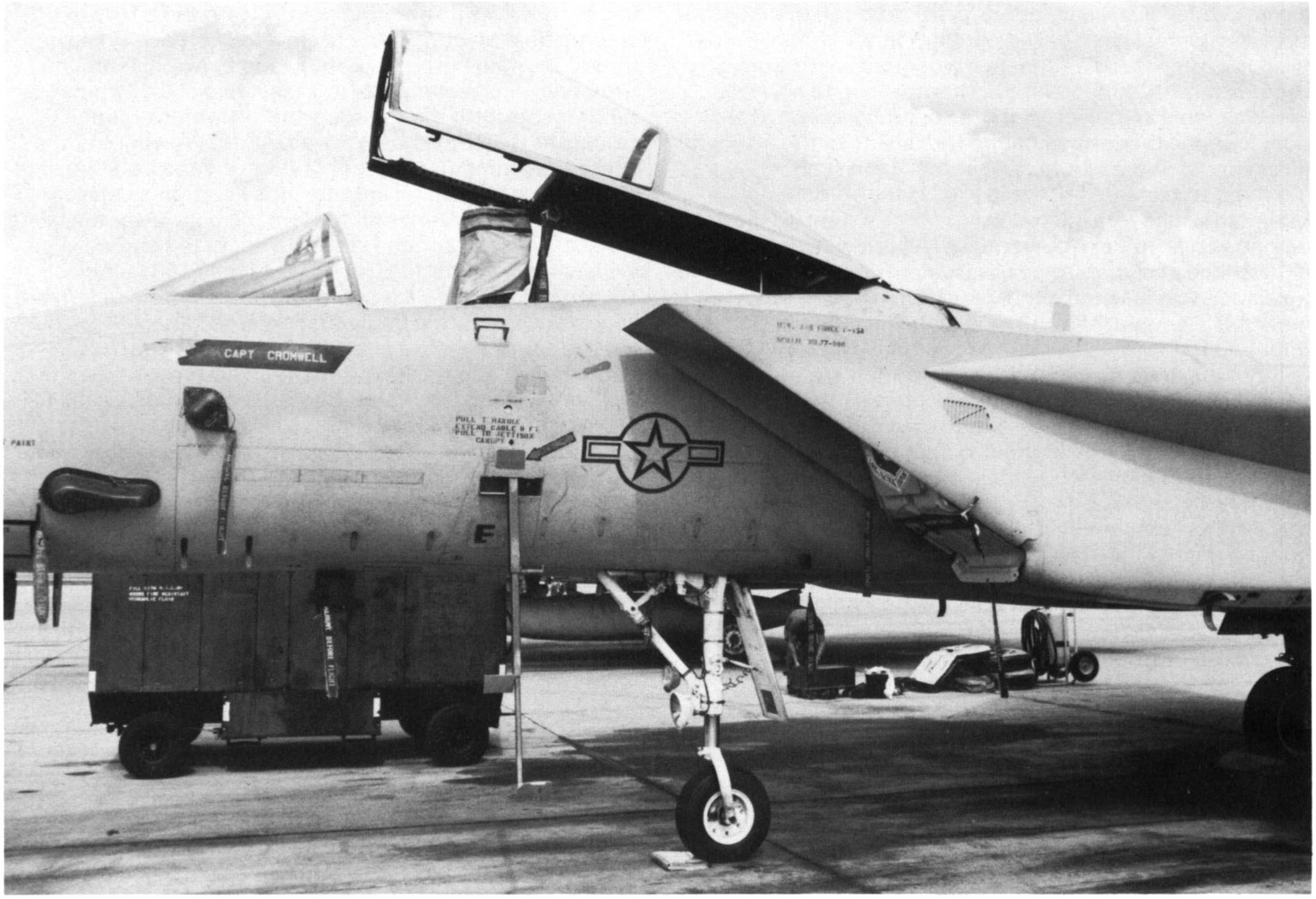
Keeping down the weight of an aircraft is a top priority for designers; of no less importance is how easily the machine can be maintained while it is on the ground. In peacetime, a good deal of money can be saved by minimising the time, effort and manpower (not to speak of

Below: The imposing lines of the F-15 at rest are captured in this view of the forward fuselage of an F-15D two-seater. The radome houses a Hughes APG-63 multi-mode system, which can range out to 100-plus miles and is optimised for one-man operation, presenting not raw data but symbology that is already analysed and needs no interpretation. The APG-63 is at the moment exclusive to the Eagle.

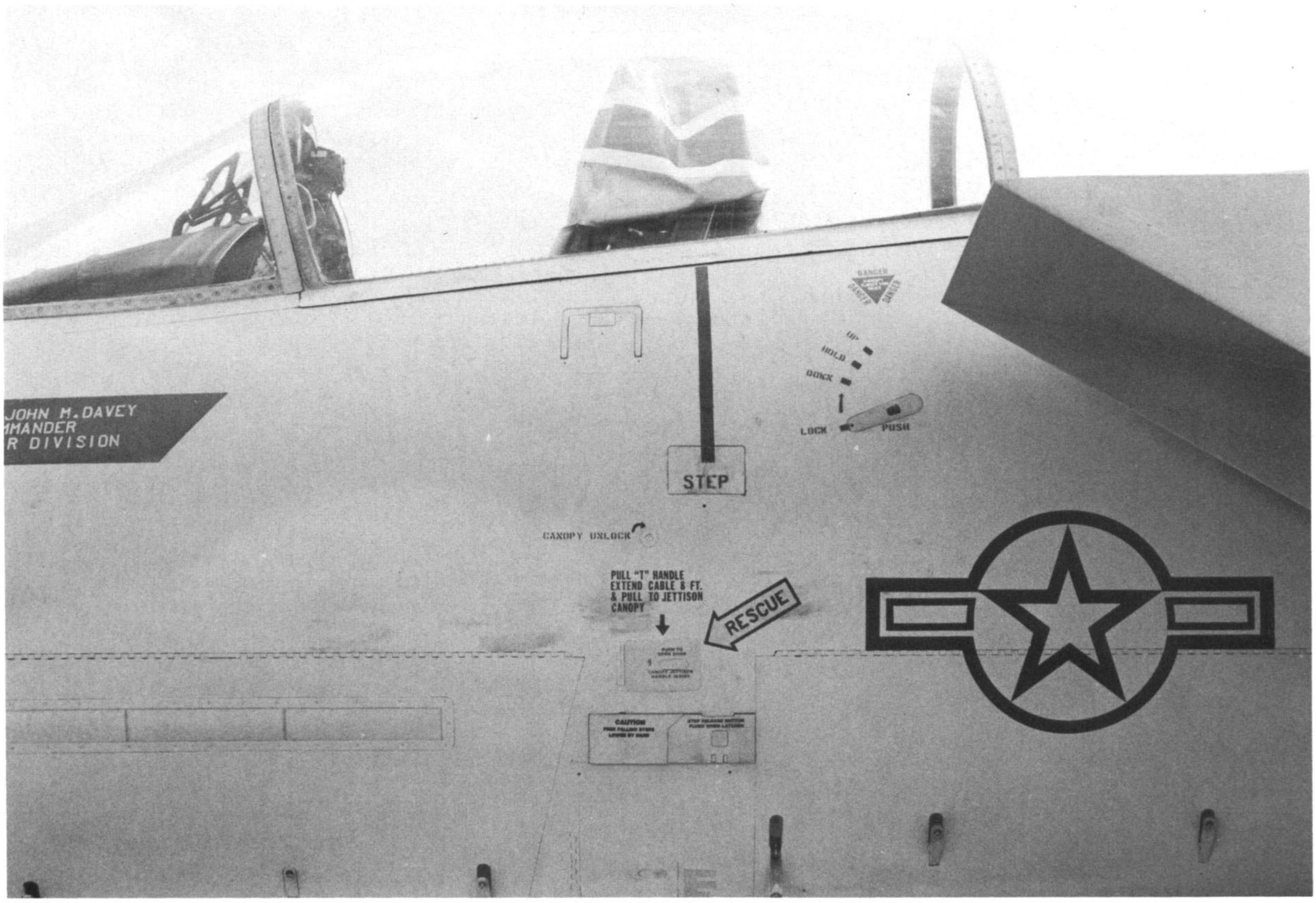
the amount of accessory equipment) required to bring the aircraft into mission-ready condition; in wartime, of course, easing the maintenance workload saves time spent in 'turn-around', and thus combat capability – the time available actually to fight the enemy – is enhanced. Considerable thought went into the design of the F-15 with this in mind, and it would appear that even such fundamental features of the layout as the shoulder-mounted wing were influenced to some extent by the demands placed on ground crews. A high wing position allowed the vast majority of the systems housed inside the fuselage to be reached either from the ground or by means of a simple 'hop-up', whilst the installation of underwing weapons and stores could be accomplished without the need for crewmen to scramble around with bent backs. Access panels smother the airframe, enabling minor servicing etc to be attended to without the need to remove large sections of the skinning by means of heavy lifting gear, and the engines, the two really big components that need to be offloaded at regular intervals, can be disconnected from the rear fuselage and slid out in under half an hour. As a further aid to maintenance, several of the aircraft's major components, including the wings, radome and canopy, are interchangeable with those of other F-15s, and so damage to any of these will not necessarily put the machine in question out of action; in time of war, 'cannibalisation' is thus made easier. Furthermore, the horizontal and vertical stabilisers are not 'handed' and thus can be swapped port to starboard and *vice versa* if required.

The F-15 Eagle is a big fighter, which sits high off the ground. The frontal aspect is dominated by the long, slightly downward-pointing nose, giving the pilot a good forward field of view from his elevated vantage point some 10ft off the ground. Behind and below him are the two cavernous rectangular intakes, the ducts of which evolve subtly into the rounded contours of the engine casings as they travel backwards. At the top edges of the intakes, prominent wing root fairings extend back beneath the wings to take on an angular cross section as they first broaden and then taper off to form the booms for the tail surfaces. At the back, the sheer power of the aircraft is evident from the huge black holes of the F100 tailpipes. The latter have been the subject of some modification in appearance since the Eagle first entered service, and the sealing petals over the afterburner actuators are now rarely seen, having been permanently removed from most aircraft owing to the maintenance problems they caused. The port and starboard tail fin tips terminate in a radar homing and warning (RHAW) receiver pod and a forward-looking electronic countermeasures (ECM) pod respectively. The pods are of unequal size, with the larger on the port tip, although on most F-15s in service with the Japanese Air Self-Defence Force both are of the smaller type. RHAW gear is also installed on the forward contours of the wing tips.

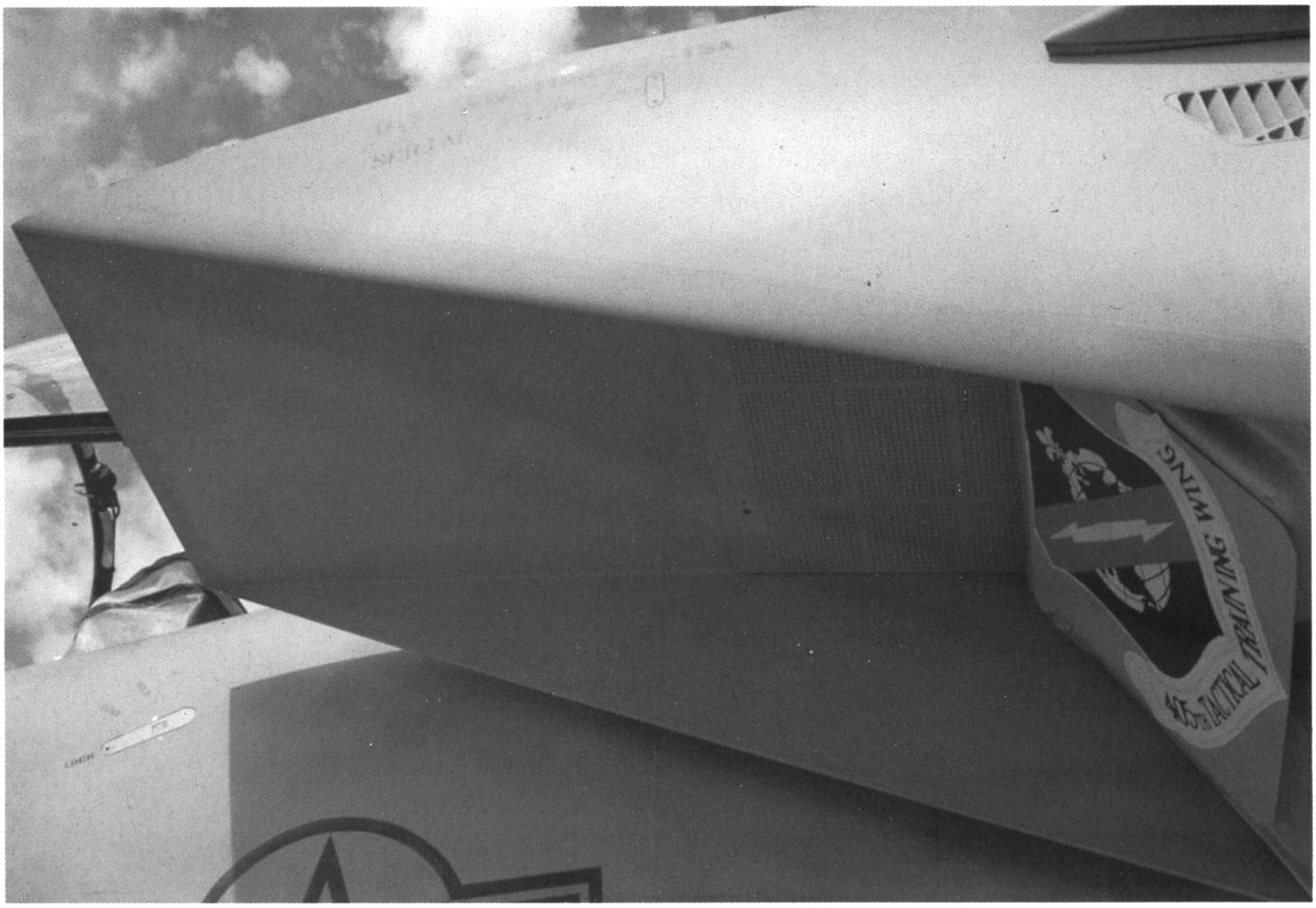
Below: The two-seater F-15s differ from the single-seaters (examples of which can be discerned in the background of this photo) in terms of the cockpit configuration and in virtually no other way; even the external dimensions are the same. These aircraft are used as trainers, with the rear cockpit a simplified edition of the front, but in combat the F-15Bs and -Ds would be used in exactly the same way as single-seaters.



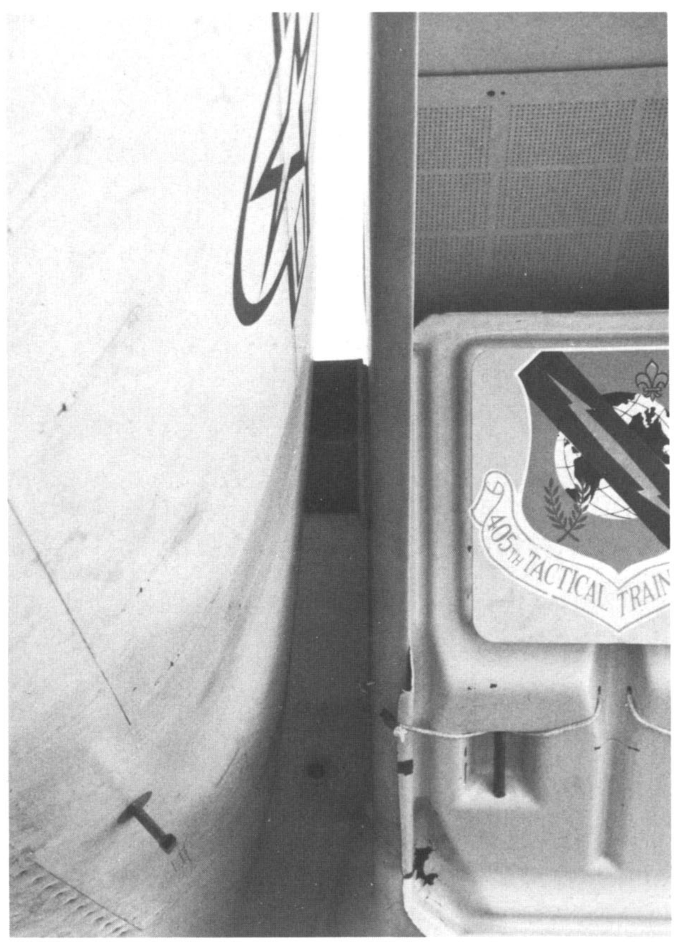
Above: Forward fuselage of an F-15A, showing extendible crew access steps and, near the canopy sill, the pull-out hand hold; another step, below this, has not been folded down in this photo. Protective covers conceal the pitot head (forward) and incidence vane.
Left: F-15D with canopy raised, its support strut and sill locks visible. Note the formating strip light low on fuselage side.
Right, top: Detail view of F-15A, showing stencilling and information decals beneath the cockpit on the port side. National insignia is in 'outline' style, in keeping with the low-visibility paint schemes of most of today's USAF fighter aircraft.
Right, bottom: F-15D crew access. Note that here an individual ladder is in place to enable the crew to embark. The sharply raked main intakes either side of the forward fuselage are pivoted at their bases to enable them to pitch up and down, thus controlling the volume of air that enters the inlet ducts.


JOHN M.DAVEY
MMANDER
R DIVISION
STEP
CANOPY UNLOCK
PULL "T" HANDLE
EXTEND CABLE 6 FT.
& PULL TO JETTISON
CANOPY
RESCUE
DANGER
UP
HOLD
DOWN
LOCK
PUSH

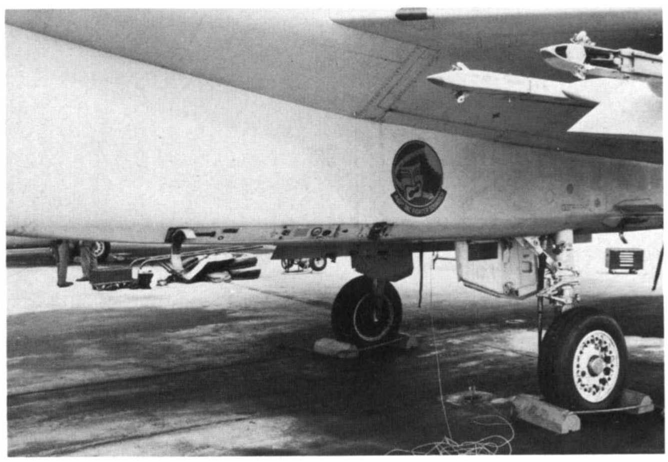

8573

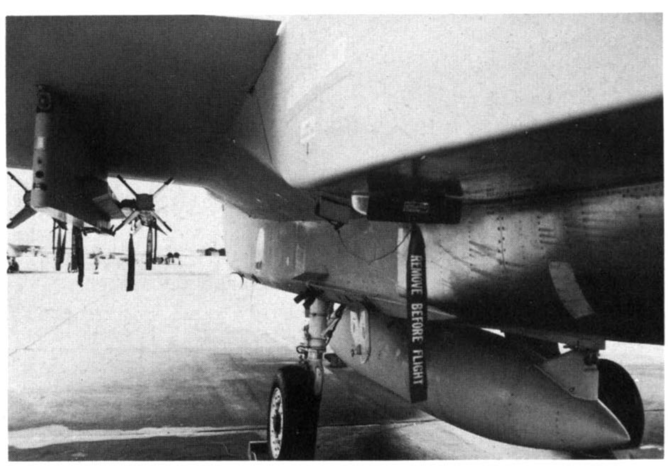


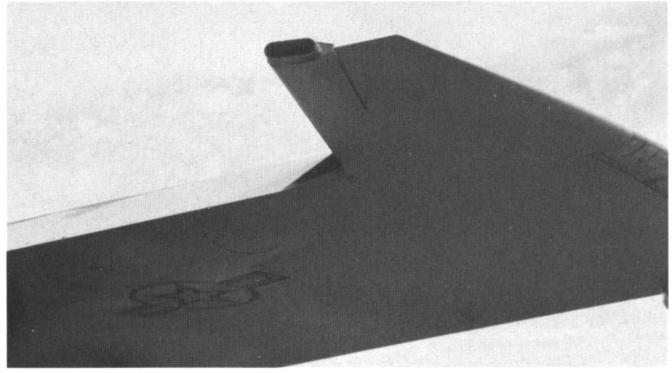
This page: Close-in views of the port main intake; the decorative anti-FOD baffle is typical of F-15 squadron equipment. At the top of the intake, inside, can be seen the first of three internal ramps. Like the front section of the intake proper, these are hinged, and can close down the area of the aperture that is presented to the air stream, diverting unwanted air through the top of the intake surface by means of bypass doors. Operation of the ramps is automatic.

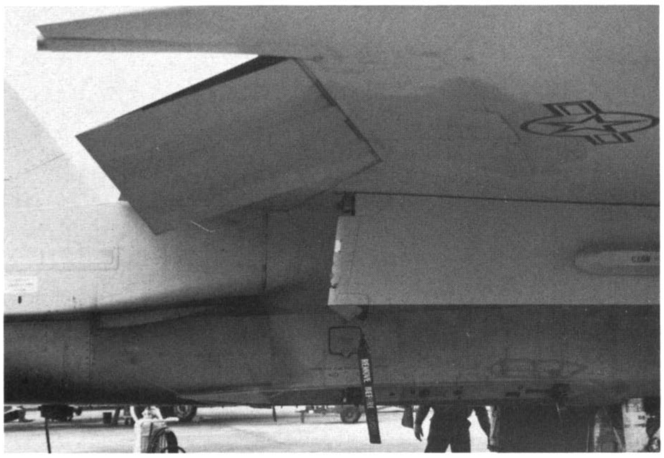


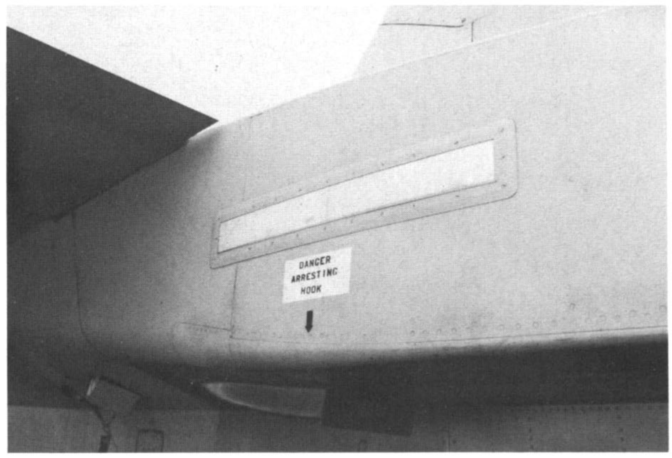
This page: Views along the intake ducts, showing the angular appearance of the wing root fairings; note the abrupt change of cross-section beneath the inboard flap area. Typically, the squadron insignia is carried on the port intake duct and the wing badge on the starboard duct. The attachment points for the aircraft's medium-range missiles are clearly evident along the lower edges of the duct. Fuel tank seen in two of the photos can accommodate 500 gallons (600 US gallons).



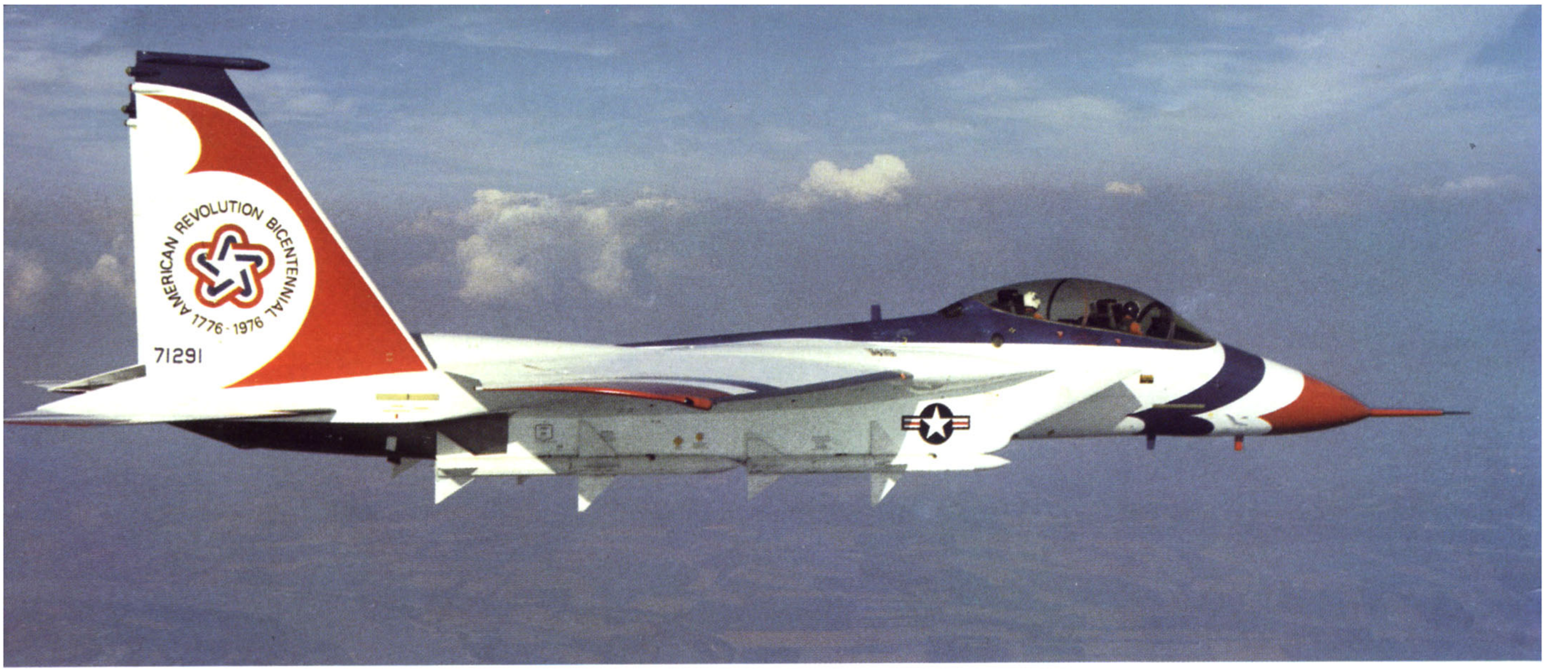







DANGER
ARRESTING
HOOK

Left: Another of the 405th TTW's units is the 555th TFTS, one of whose F-15s is seen here toting its full complement of AIM-7 and AIM-9 missiles. *McDonnell Douglas*
Far left, below: A pair of 43rd TFS (21st TFW) F-15As, photographed from an F-15B two-seater, up from Elmendorf Air Force Base in Alaska. The role of the 21st is particularly vital since its aircraft patrol that part of United States territory closest to the Soviet Union. *McDonnell Douglas*
Above: An F-15B takes on fuel. This photo shows clearly the arrangement of the air bleed outlets above the intakes and the gas vent louvres for the M61 cannon in the starboard wing root fairing. *McDonnell Douglas*
Below: The F-15's airframe, when factory-fresh, is smothered in a mass of stencilling, as can be seen in this excellent photo of 59th TFS (33rd TFW) Eagles based at Eglin. *McDonnell Douglas*


AMERICAN REVOLUTION BICENTENNIAL
1776 · 1976
71291


AF
86
183

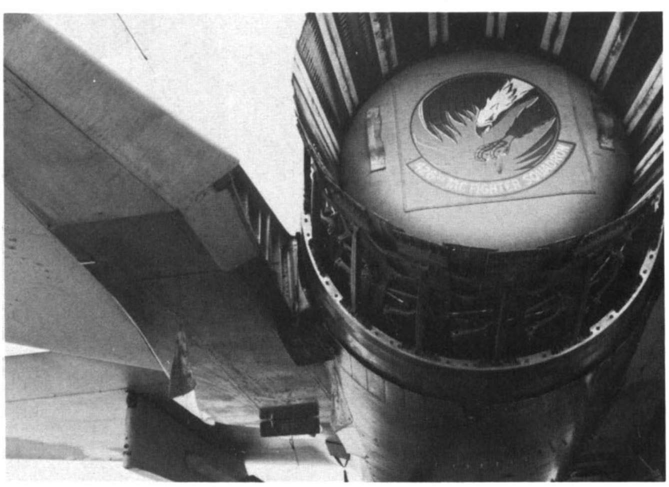
Opposite page: F-15 wing details. Around the wing tips, from front to rear, are the white dome of the RHAW (radar homing and warning) antenna; the tip navigation light; the low-voltage formation strip light; and, on the trailing edge, the ventilation/jettison pipe for the fuel system. The F-15 has no fancy wing control surfaces, relying on plain flaps and ailerons instead; the leading edges are fixed, though feature increasingly pronounced camber towards the tips of the wings. Note the strip light, hook warning panel and heat exchanger exhaust duct aft of flap trailing edge.
This page: Eagles of the 405th Tactical Training Wing, and more specifically the 461st Tactical Training Squadron, the 'Deadly Jesters'. Squadron colours of yellow and black are carried on the tips of the vertical tails, for the stylised 'eagle' crew name flash, for the squadron badge beneath the port wing, on the extreme tips of the Sidewinder missile launch rails and even as decorative trim on the ejection seat covers.

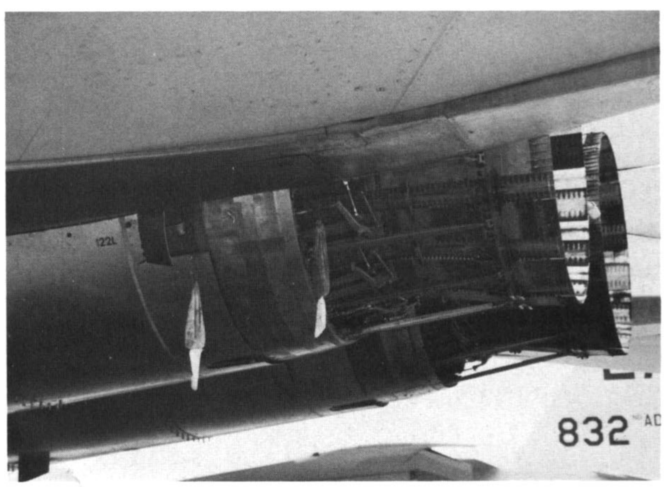

LA
0062

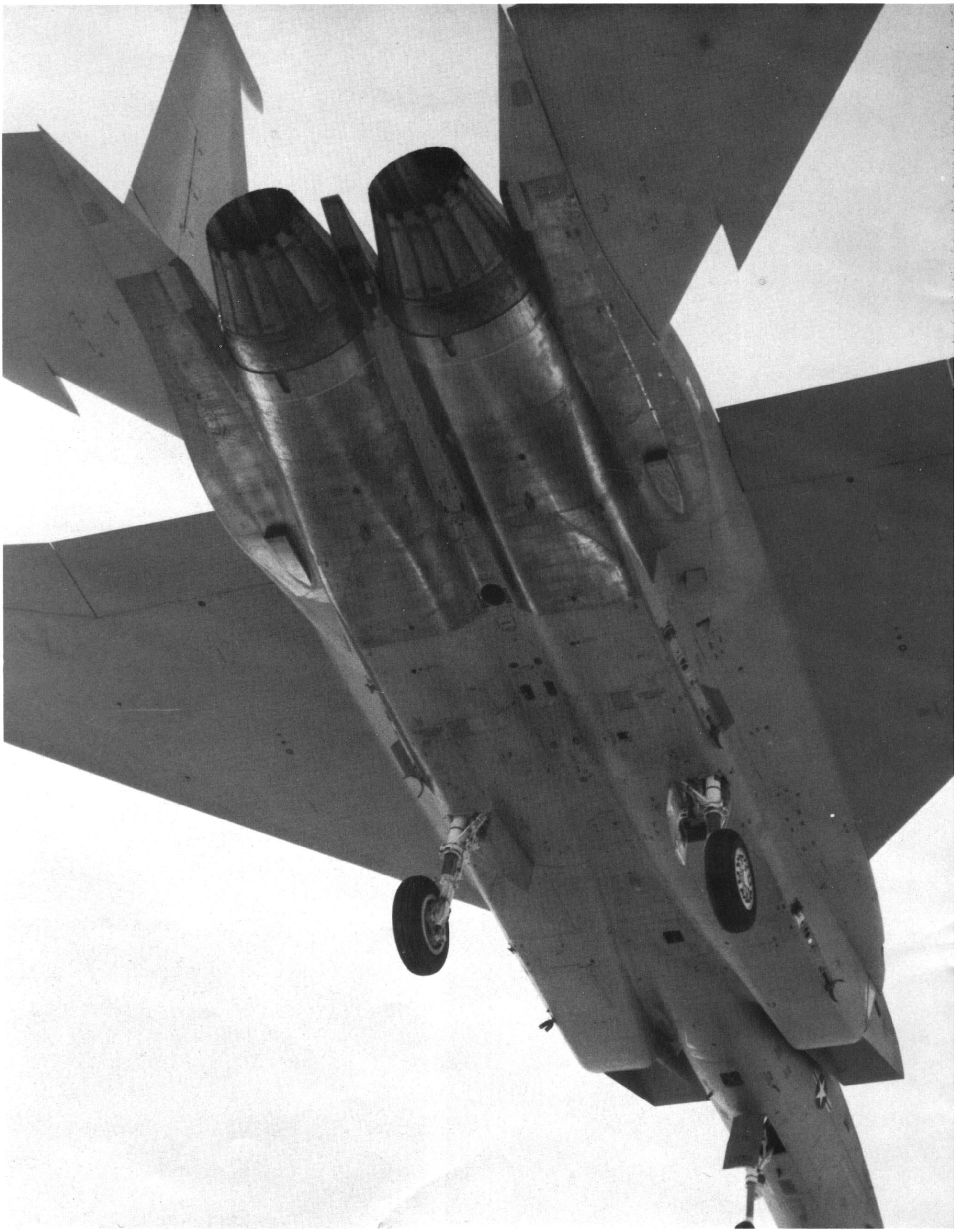

EG

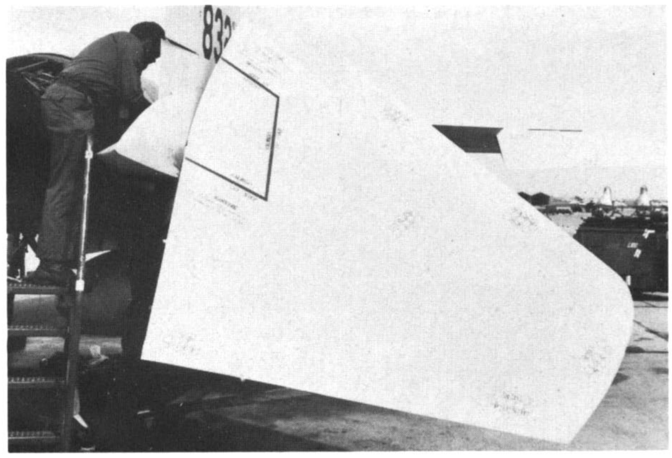
Opposite page, top: The second two-seat F-15, all dressed up for the 1976 US Bicentennial celebrations. *McDonnell Douglas*
Opposite page, centre: The same aircraft five years later, acting as the manufacturer's demonstrator for the Strike Eagle proposal. *McDonnell Douglas*
Opposite page, bottom: The first F-15E, equipped with fuel tanks and intake-mounted LANTIRN pods. *McDonnell Douglas*

Above: Rear view of an F-15, showing how the flying surfaces at the tail are not mounted directly on to the fuselage structure but are carried on 'booms' either side of the tail pipes.
Below: The aircraft's tail pipes have now had their aerodynamic 'petals' removed, easing considerably the task of afterburner maintenance. Note structure of stabiliser visible along inboard edge and 426th TFTS ('Killer Claws') badge on tail pipe baffle.



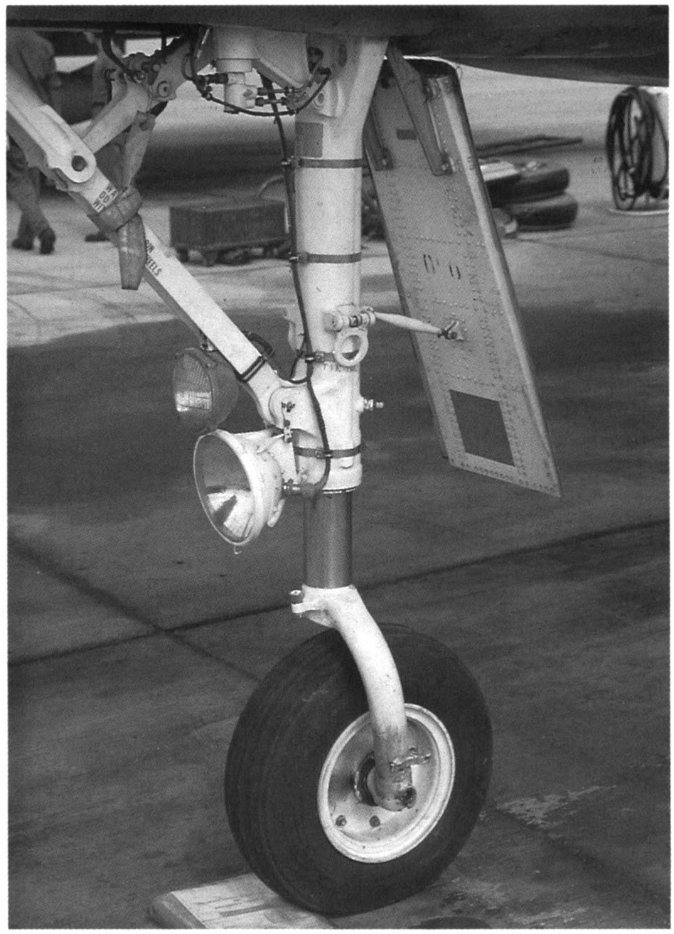






Opposite page: A 'clean' F-15 passes low over the camera to give a detailed view of the aircraft's undersurfaces. Engine casings are unpainted, and note that this early Eagle has the original engine nozzle configuration. *McDonnell Douglas*
Above left: Arrester hook, in black and white finish.

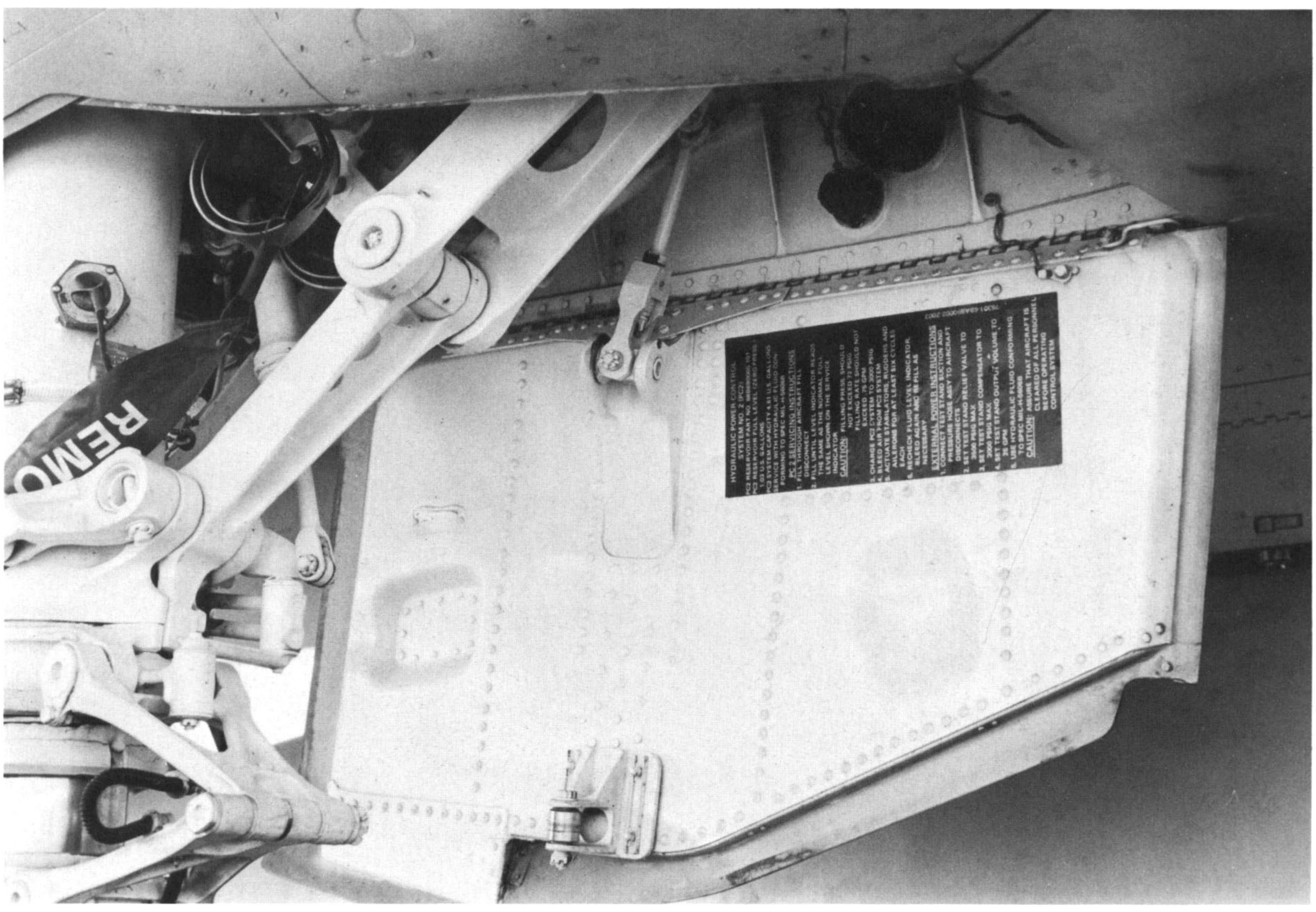
Above right: Starboard horizontal stabiliser, showing layout of walkway area (adjacent to pivot point) and 'no step' markings.
Below: Twin vertical stabilisers have unequal-sized pods at their tips, with ECM domes and tail navigation lights immediately beneath on the trailing edge.



Opposite page: F-15 nose gear is equipped with a landing light (lower) and a taxiing lamp. The forward nose bay door is normally to be seen closed up when the aircraft is parked.
Above: General view of main undercarriage, showing ease of access to the fuselage stores pylon.
Left and below: Port main gear, with safety chocks in place.

This page: A small visual clue as to whether an Eagle is an F-15A/B or an F-15C/D is the style of wheel, small revisions to which were made with the introduction of the upgraded aircraft. This is the main gear of an F-15D, and can be compared with that of an F-15A opposite. Brake system and tyres are also slightly changed on the later variants.
Opposite page: Starboard main gear. Note 832nd Air Division insignia on wheel hub, superimposed on the 426th's squadron colour (red). In contrast to the nose gear, the main wheel legs are fitted with torque links. The degree of oleo compression suggests that this particular aircraft is fuelled.


832AD



MISSION

The history of postwar military aircraft development has been characterised by dramatically rising costs, brought about by natural inflation compounded by the demand for ever-increasing technological sophistication in order to cope with what are perceived as ever more formidable threats. On average, each new combat aircraft has, as a result, cost more than twice that of the machine it has replaced, and since the mid-1960s the figure has often been more than three times as much. It has already been noted that 'total package procurement', as applied to the F-15 and other US aircraft, was, in part, a determined attempt to bring down the cost of individual aircraft, or at least slow down its rate of increase; another measure pressed for by purchasing authorities (usually governments) has been to assign to one particular airframe a multitude of diverse tasks, some of them clearly difficult to combine.

Even the United States, with all its capital resources, has felt the pressure, but in the case of the FX it seemed as though the hardware which would finally emerge would be a dedicated air superiority, interception and escort fighter, its design uncompromised by any requirement to carry bombs, air-to-ground missiles, reconnaissance packages and the like. The weapons to be fitted comprised a fixed integral gun, four short-range ('dogfight') missiles, and four medium-range missiles for BVR (beyond visual range) encounters. AAM carriage was particularly neat, with the medium-range missiles (AIM-7 Sparrow) mounted 'conformally' in shallow troughs along the outboard corners of the intake ducts and the close-range weapons (AIM-9 Sidewinders) installed in pairs on wing pylons well inboard. A centreline fuselage pylon was provided so that external fuel could be carried, whilst the hardpoints on the wings were also plumbed for fuel tanks. The design of the wing pylons was such that tanks could be accommodated without interference with the primary missile armament.

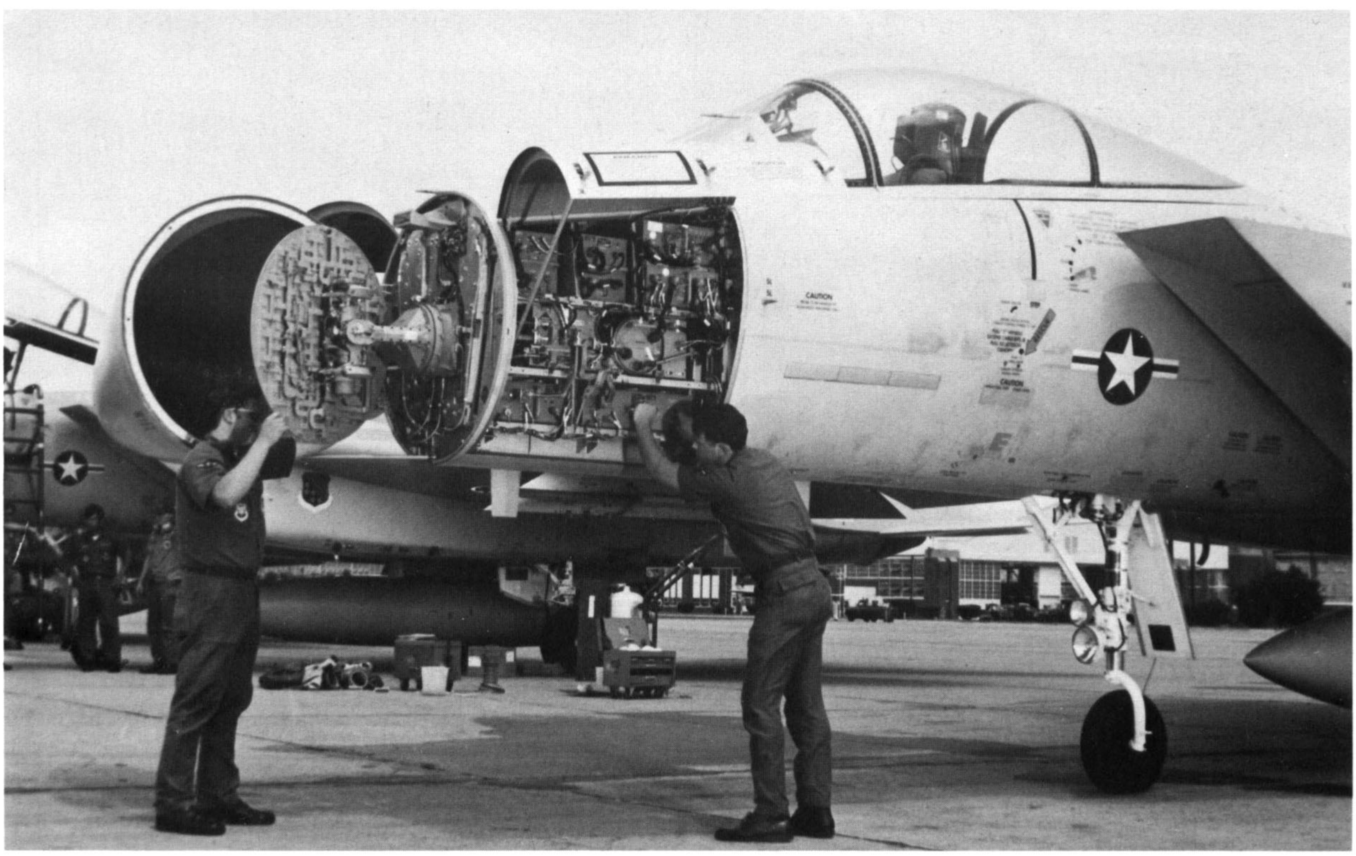
It was in this guise that the F-15 entered service, but inevitably the question began to be asked: If fuel tanks can be accommodated without any reduction in the AAM load, why not bombs? With the F-15's spare load capacity in the fighter role, the logic of the question could hardly be countered, and so work began to clear the aircraft for the carriage of multiple ejector racks (MER), a development which ultimately resulted in the building of the Strike Eagle and the subsequent adoption by the US Air Force of the F-15E. However, the fighter role of the basic aircraft has in no way been compromised by this additional capability, and one consequence is that the F-15, while impressive in appearance as an attack aircraft, is, according to some commentators, not ideally suited to the task: in particular, they say, its wings were designed for medium- and high-altitude combat, and strike missions these days generally call for low-level flights beneath the radar beams, where strong air currents ('gusting') can cause the crew acute discomfort unless wing design is optimised for this sort of mission. The introduction of FAST packs for the F-15C and -D has enhanced the attack capability further, McDonnell Douglas having devised 'tangential' bomb racks for these pallets.

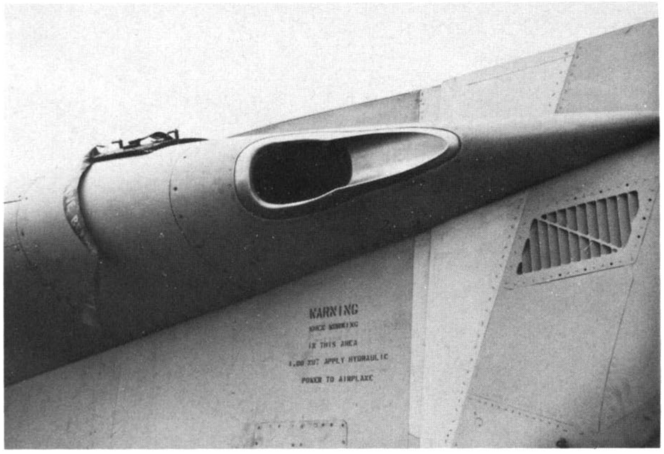
A more specialist role envisaged for the Eagle, and one that must be more in keeping with the aspirations of its designers, is the destruction of hostile satellites. A dedicated missile, known as ASAT, has been developed by Vought and Boeing. The concept, whilst having been talked about ever since Sputnik 1 was placed into Earth orbit back in 1957, is technologically extremely difficult, and it is only with the advent of the F-15, its spectacular capabilities demonstrated by the record-breaking Streak Eagle, that it has become feasible. The ASAT missile is a two-stage weapon based on the SRAM (Short-Range Attack Missile) already in service with Strategic Air command B-52 Stratofortresses, B-1Bs and FB-111s. It has a conventional warhead, and homing is accomplished by means of an infra-red seeker. The first full test of the new missile took place in September 1985.

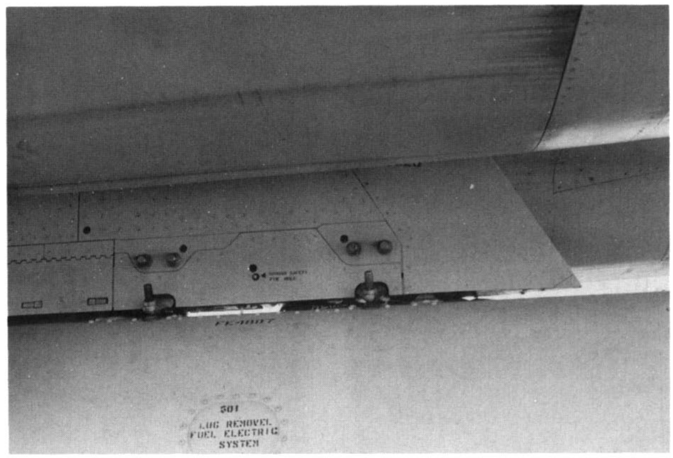
Below left: F-15A 76-0086 equipped with an ASAT (Anti-Satellite) missile, which was successfully demonstrated in September 1985 when a Solwind P78-1 satellite was totally destroyed. Weighing something over a ton and measuring some 17ft in length, ASAT is a two-stage missile for which the F-15, in effect, acts as a re-usable first stage. The future of the programme is not assured at the time of writing, but if it goes ahead two US-based Fighter Interception Squadrons will probably be designated for the role. *McDonnell Douglas*

Right: One of the 32nd TFS's F-16Cs, based at Soesterberg in the Netherlands, fully equipped for the fighter mission with AIM-7F Sparrows and, on the wing pylons, four AIM-9L Sidewinders. *McDonnell Douglas*

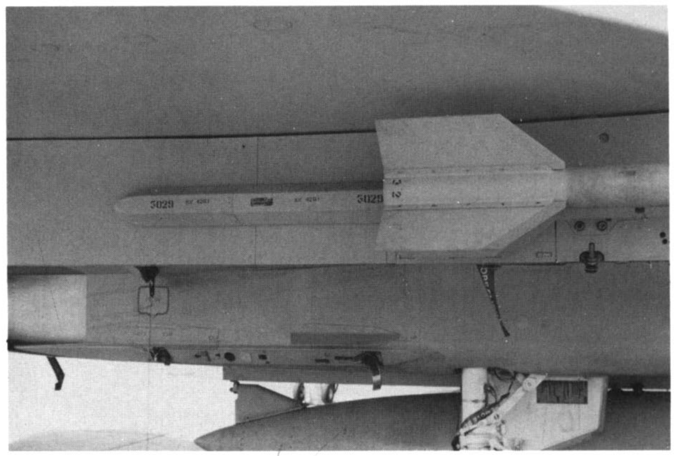
Below: An early F-15A with its radome swung open, revealing the Hughes APG-63 multi-mode radar system. The wide range of modes and frequencies of the APG-63 gives the Eagle pilot instant information at all speeds and altitudes. *McDonnell Douglas*




WARNING
DO NOT APPLY HYDRAULIC
POWER TO AIRPLANE


FUEL ELECTRIC
SYSTEM


5029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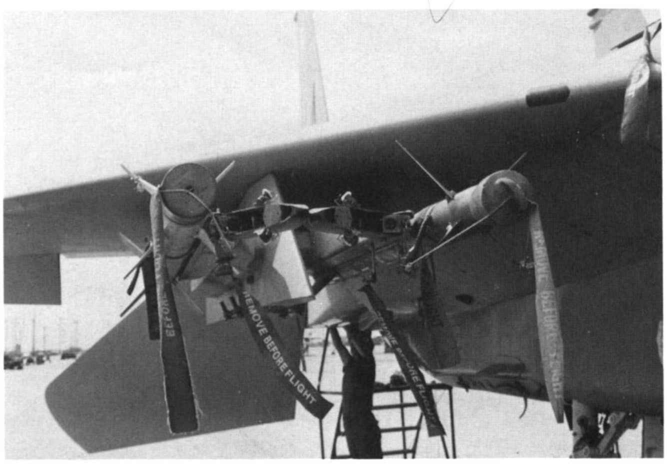
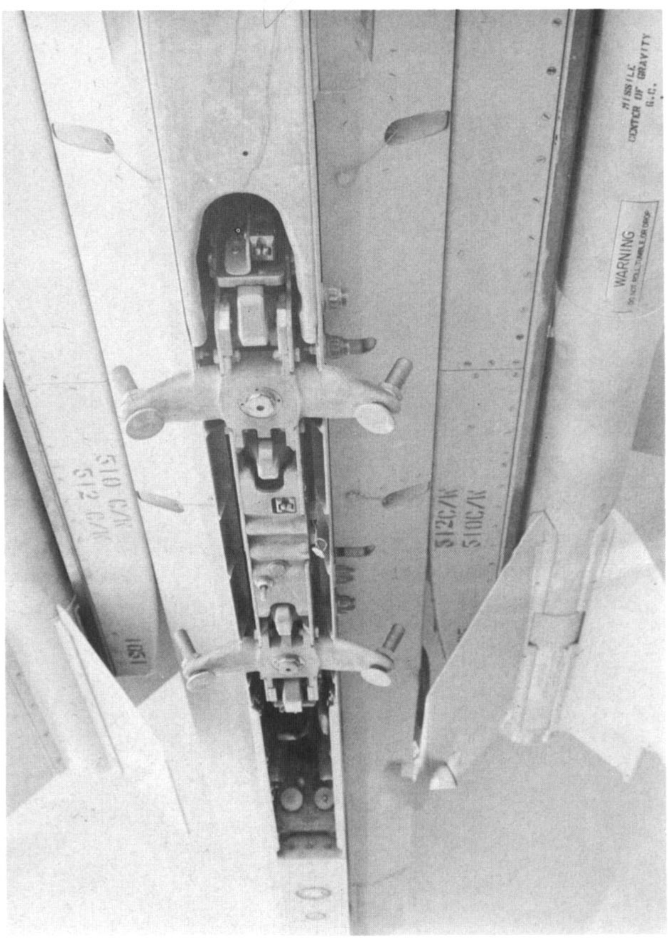

REMOVE BEFORE FLIGHT


MISSILE
CENTER OF GRAVITY
C.G.
WARNING
510 C/K
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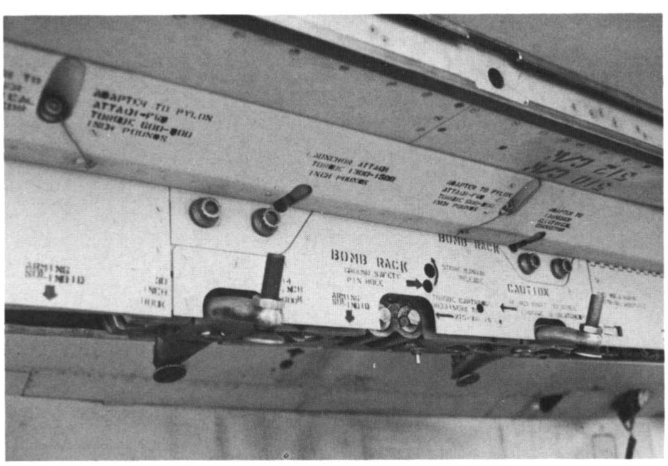
510C/K

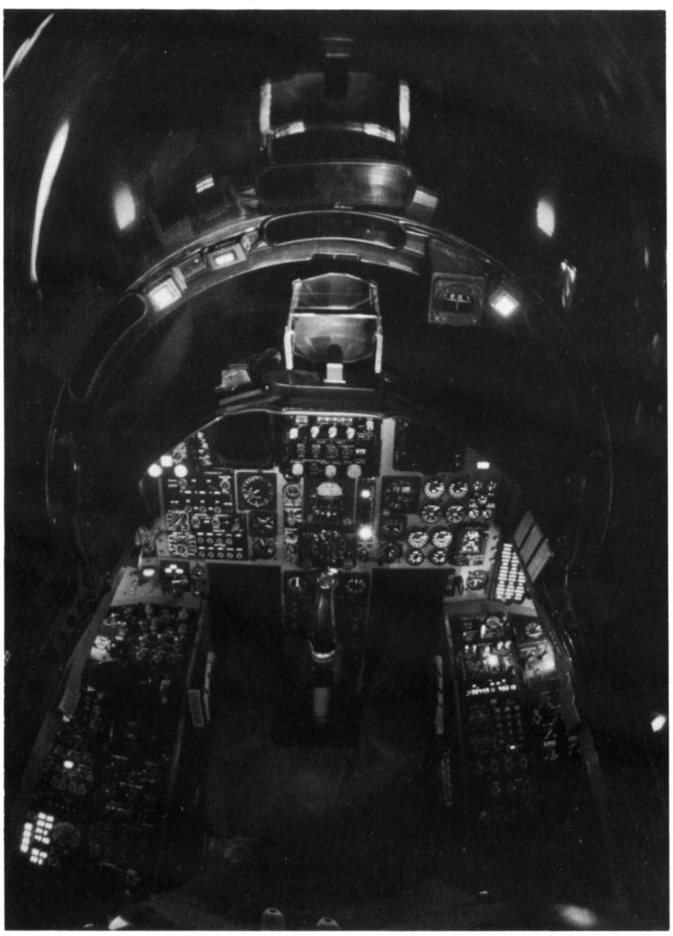

ADAPTER TO PYLON
BOMB RACK
BOMB RACK
CAUTION

Opposite page: F-15 armament details. At top left is the muzzle port of the M61 cannon, housed in the starboard wing fairing; at top right is a detail view of the front of the underfuselage pylon, showing tank attachment system. The remaining photos depict the standard inboard wing pylon (designated SUU-59/A) with missile launchers (LAU-114/A) attached to the side for AIM-9L carriage. AIM-7 launchers are recessed into the contours of the intake ducts, and are thus described as 'conformal'.

Above: Company demonstrator Eagle with FAST packs standing by. These fittings will be standard for the F-15E but can also be used by F-15Cs and -Ds. *McDonnell Douglas*

Below left: F-15 cockpit instrumentation. Rear cockpit of two-seater aircraft is much simplified. *McDonnell Douglas*

Below right: ACES II ejection seat, standard for F-15s. *McDonnell Douglas*



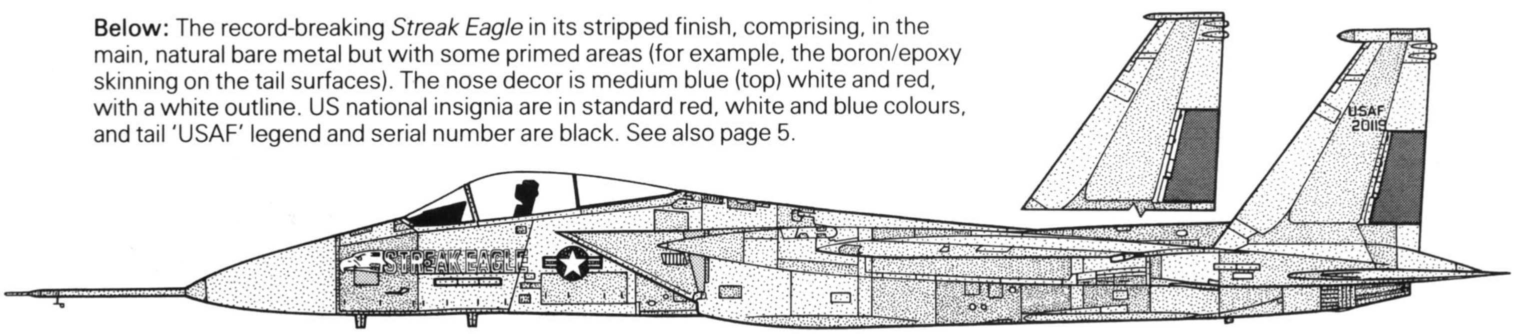
SQUADRON SERVICE

Eagle deliveries to the US Air Force began on a ceremonial note, when the first aircraft, a two-seater, was officially handed over at Luke Air Force Base in Arizona on 14 November 1974. Luke has continued to be a major F-15 base to this day (most of the photographs in this book were taken there), and the current residents make up the 405th Tactical Training Wing (tail code 'LA'), assigned to the 12th Air Force, Tactical Air Command. At present TAC operates five other F-15 wings, the 1st ('FF'), 33rd ('EG') and 49th ('HO') Tactical Fighter Wings, at Langley, Eglin and Holloman Air Force Bases respectively, the 325th TTW ('TY') at Tyndall AFB and the 57th Fighter Weapons Wing ('WA') at Nellis AFB. The 325th is part of the Air Defense TAC (ADTAC) organisation, which also encompasses the 5th (Minot AFB), 48th (Langley AFB), 57th (Keflavik AFB in Iceland) and 318th (McChord AFB) Fighter Interception Squadrons, alone amongst which the F-15s of the 57th FIS carry a tail code, 'IS'. In addition, Tactical Air Command has on strength the 4485th Test Squadron ('OT') at Eglin, whilst the 21st TFW ('AK'), based at Elmendorf AFB, is part of Alaskan Air Command.

Elsewhere outside the United States, F-15s are deployed in Europe (under USAFE command) and in Okinawa (under Pacific Air Forces, PACAF). Bitburg in West Germany and Soesterberg in the Netherlands are home for the 36th TFW ('BT') and 32nd TFS ('CR') respectively, and the 18th TFW ('ZZ') is resident at Kadena in the Far East. From 1985 Air National Guard units began to receive F-15As and -Bs with the re-equipping of the 122nd TFS, Louisiana ANG, and continuing with the 128th TFS, Georgia ANG, in 1986. Further ANG units will receive Eagles as the number of aircraft available builds up. Three other US Air Force units operate F-15s, Air Force Systems Command's 3246th TW ('AD') at Eglin and 6512nd TS ('ED') at Edwards AFB, the latter part of the Air Force Flight Test Center inventory; and Air Force Logistics Command's single aircraft (tail code 'RG'), based at Robins AFB, Georgia.

In Japanese service the F-15J and -DJ two-seater at present equip five front-line squadrons (*hikotai*), the 203rd and 207th at Chitose, the 202nd and 301st at Nyutabaru and the 204th at Hyakuri, plus the Air Proving Wing at Gifu. The initial order for 100 aircraft is expected to be expanded shortly to enable two more squadrons to be formed, raising the total F-15 strength by about 50 per cent. The Saudi Eagles are reported to equip three units, No 5 Squadron at Taif, No 6 at Khamis Mushayt and No 13 at Dhahran. The aircraft comprise 47 F-15Cs and 15 F-15Ds, but since international agreement limited to sixty the number of F-15s that could permanently be deployed on Saudi soil a couple of the aircraft were at first retained in storage in the United States. The Israelis, as always, are very coy about which of their squadrons fly F-15s, and although squadron insignia are displayed on individual aircraft the official censor invariably blots out such features from IDF/AF photographs.

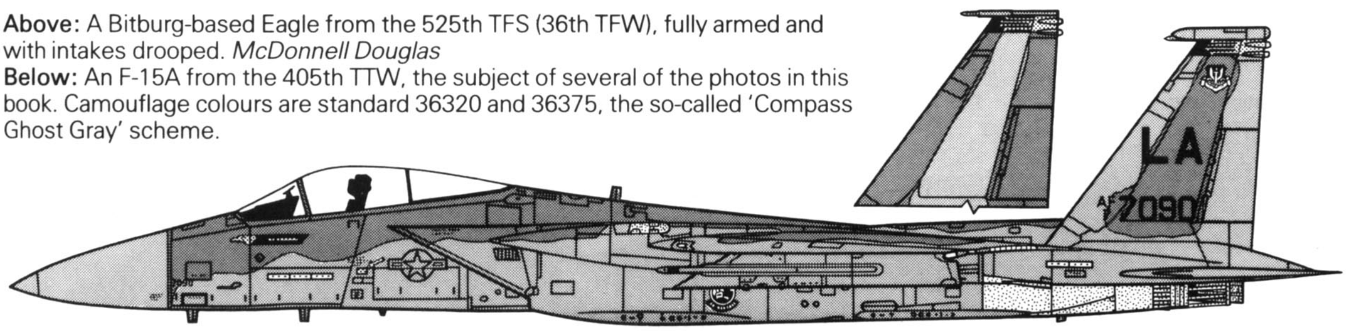
Below: The record-breaking *Streak Eagle* in its stripped finish, comprising, in the main, natural bare metal but with some primed areas (for example, the boron/epoxy skinning on the tail surfaces). The nose decor is medium blue (top) white and red, with a white outline. US national insignia are in standard red, white and blue colours, and tail 'USAF' legend and serial number are black. See also page 5.

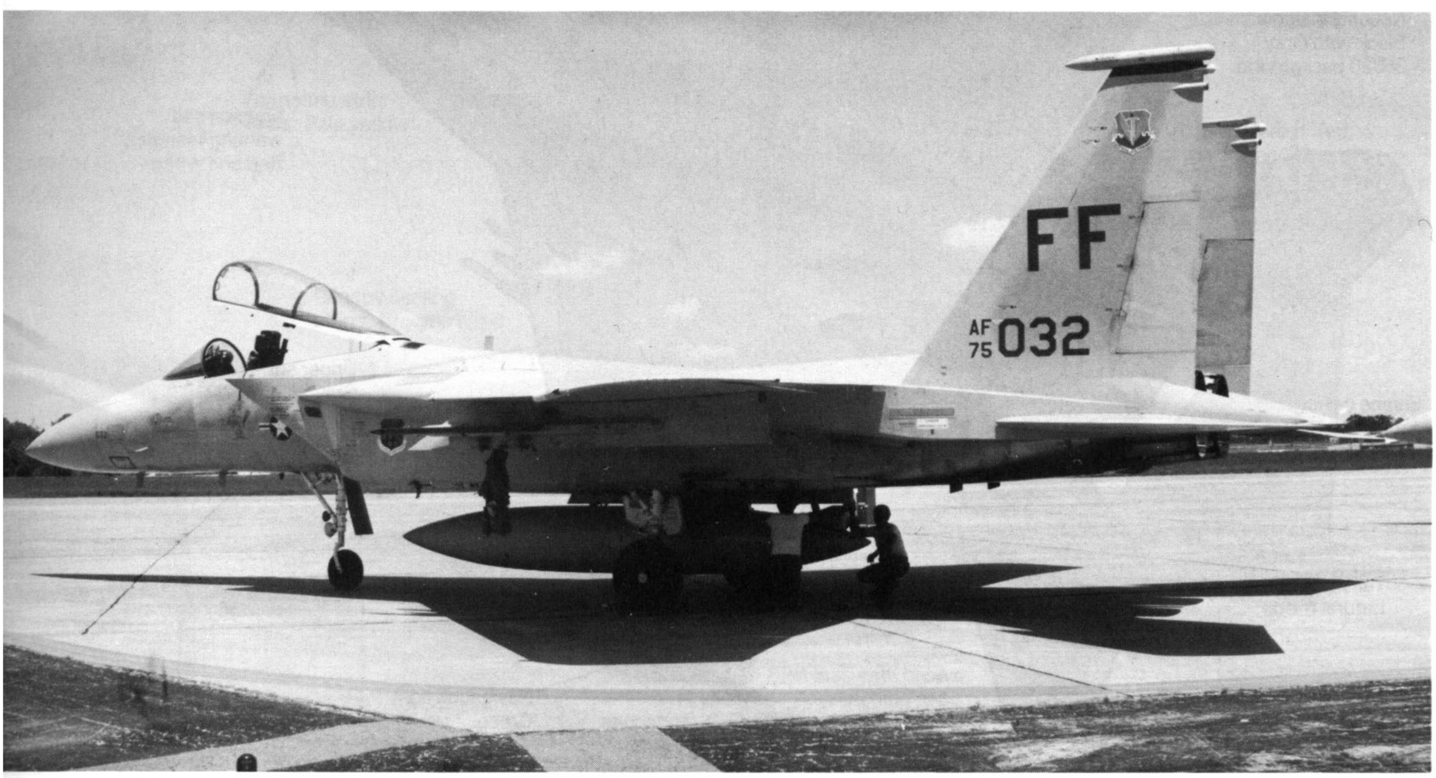


Left: Arming the rear starboard Sparrow station; the lower fins of the missile will be fitted once the weapon is in place. The forward station is as yet unoccupied. The aircraft is from the 49th TFW, and the yellow fin-tip band (and the exaggerated final number in the tail serial) identifies it as an 8th TFS machine. Note the protective plastic caps over the Sidewinders' seekers. *McDonnell Douglas*

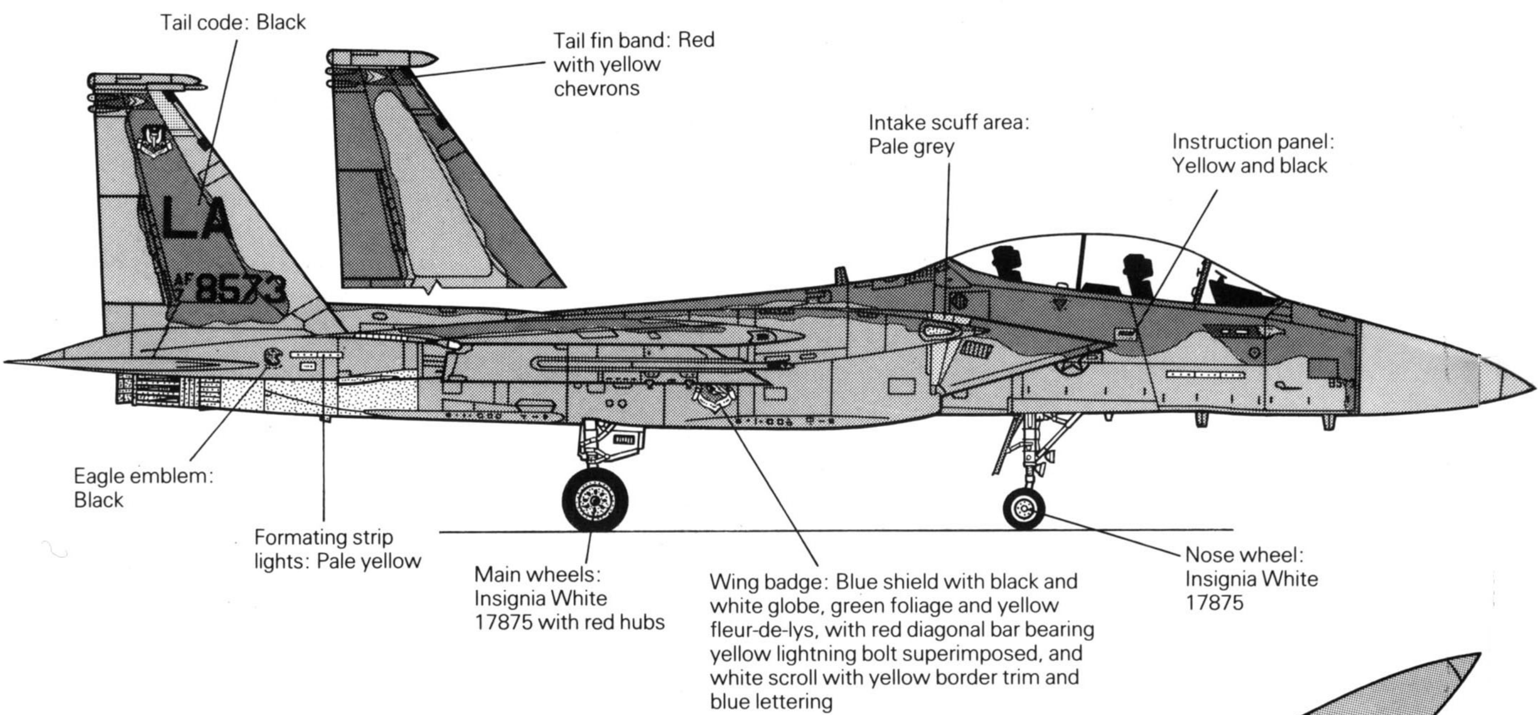
Right: 'FF' on the tailfin proclaims the 1st TFW, based at Langley AFB, the first operational wing to equip with the F-15. Tail decor is in 'textbook' style, with TAC badge, wing code letters and Air Force serial in perfect position; variations do occur! Note that the national insignia carried by this aircraft is in the regular colours, though lacks the traditional blue outline. *McDonnell Douglas*

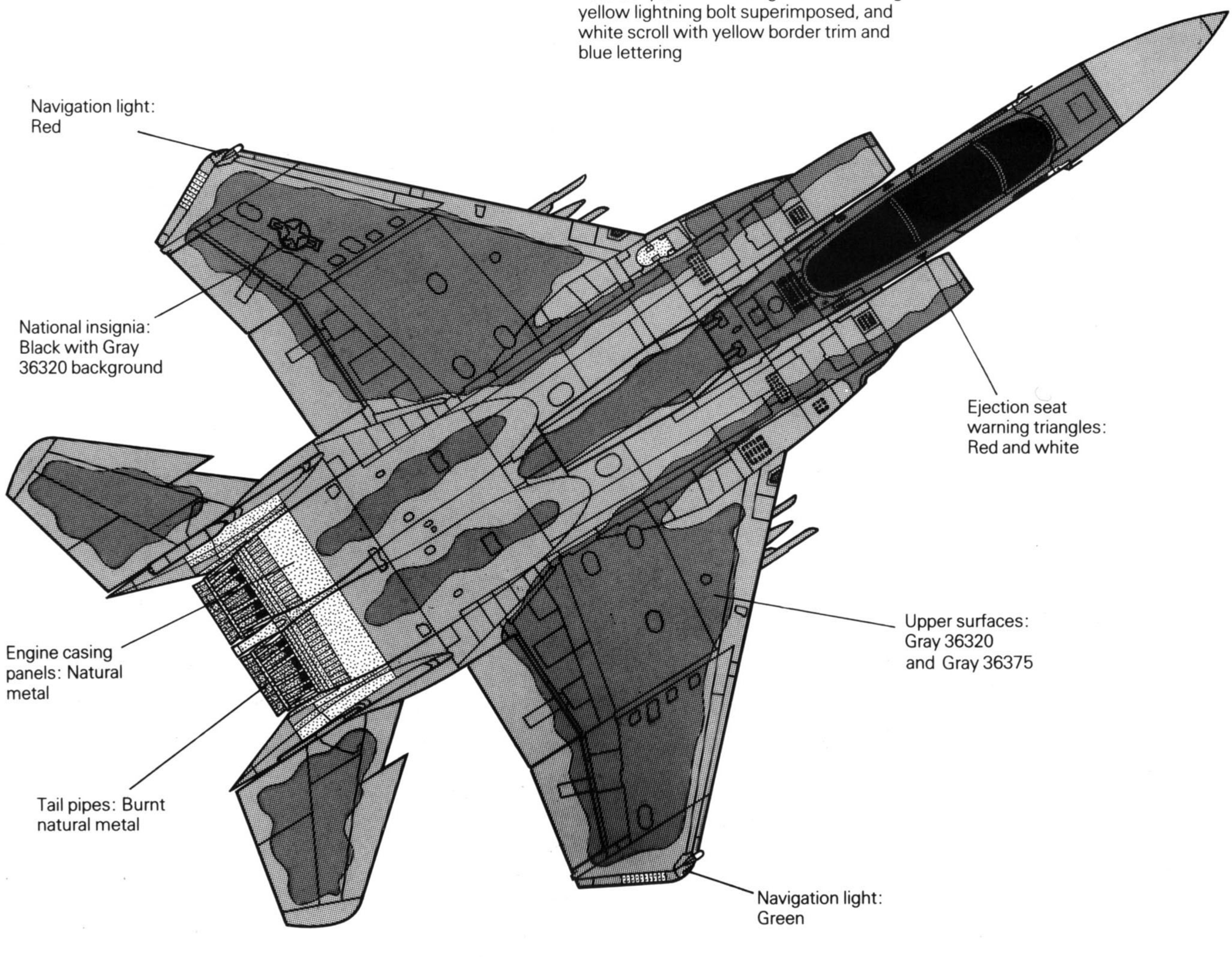
Above: A Bitburg-based Eagle from the 525th TFS (36th TFW), fully armed and with intakes drooped. *McDonnell Douglas*
Below: An F-15A from the 405th TTW, the subject of several of the photos in this book. Camouflage colours are standard 36320 and 36375, the so-called 'Compass Ghost Gray' scheme.





McDONNELL DOUGLAS F-15D EAGLE, 426th TFS (405th TTW), LUKE AFB, MAY 1985





Numbers refer to Federal Standard (FS) 595a listings

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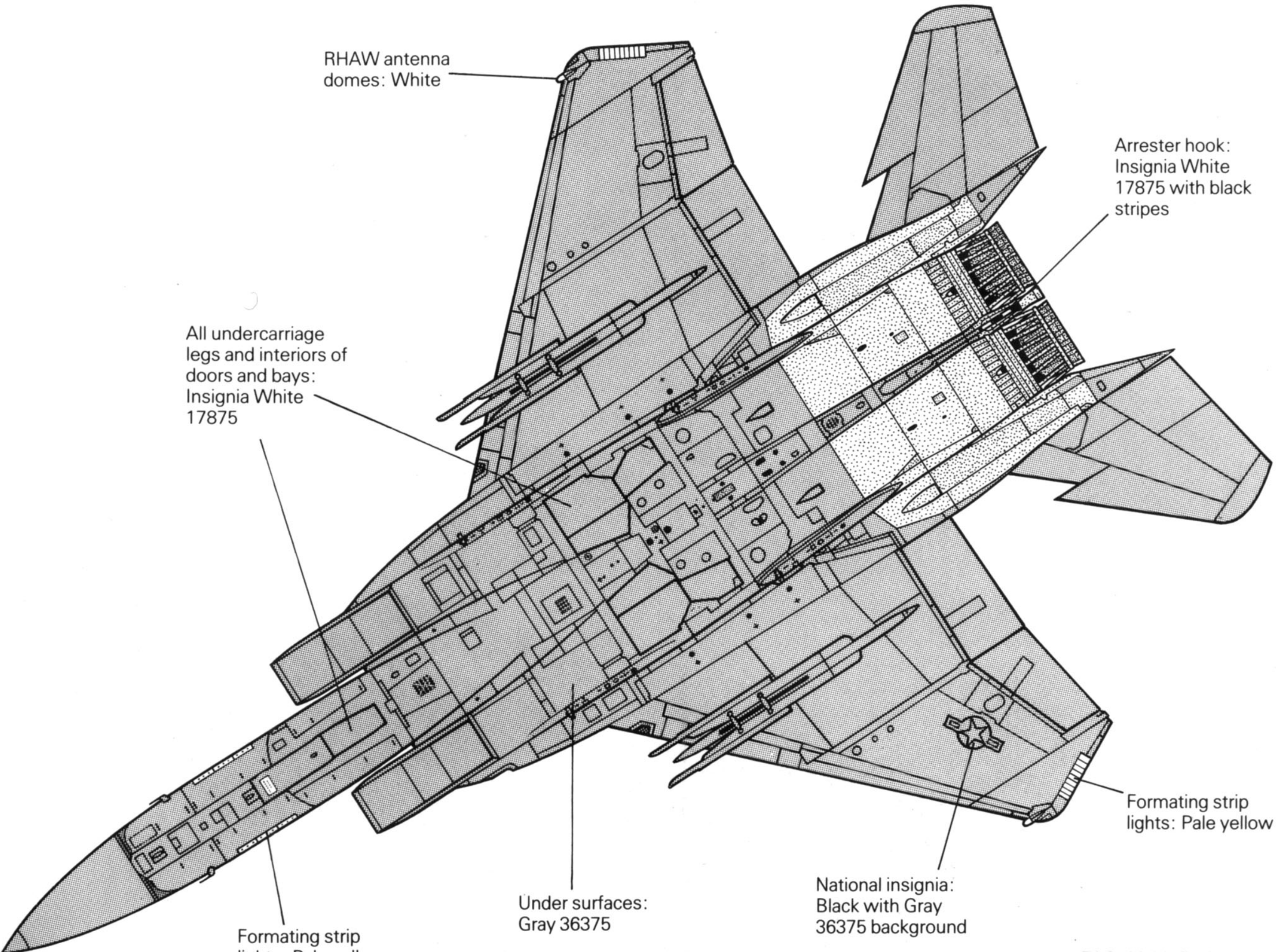
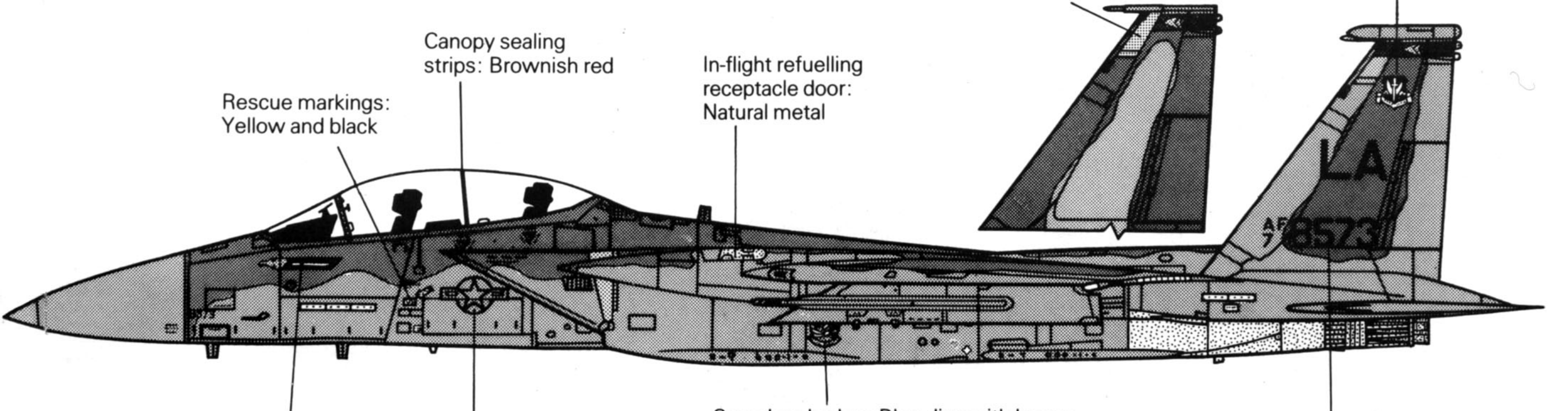
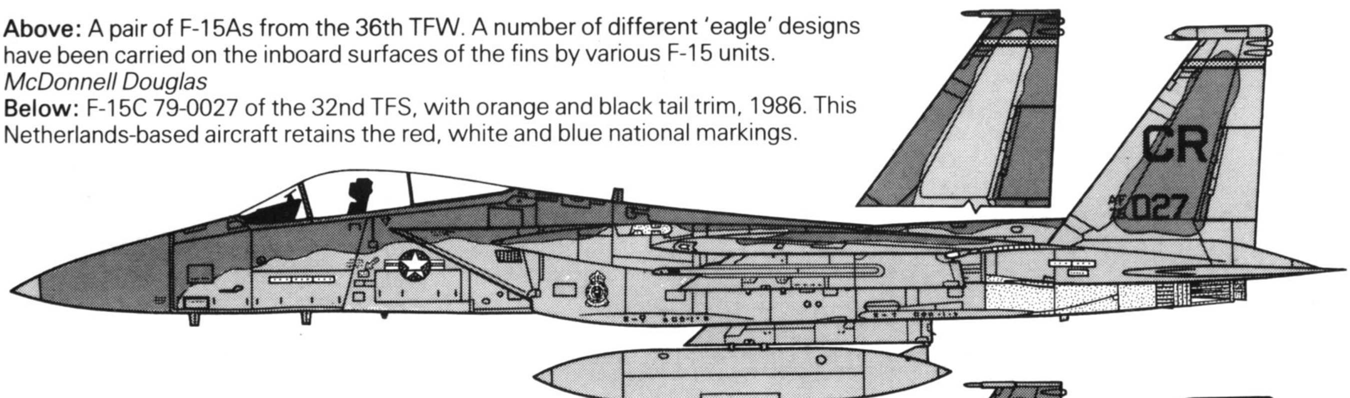


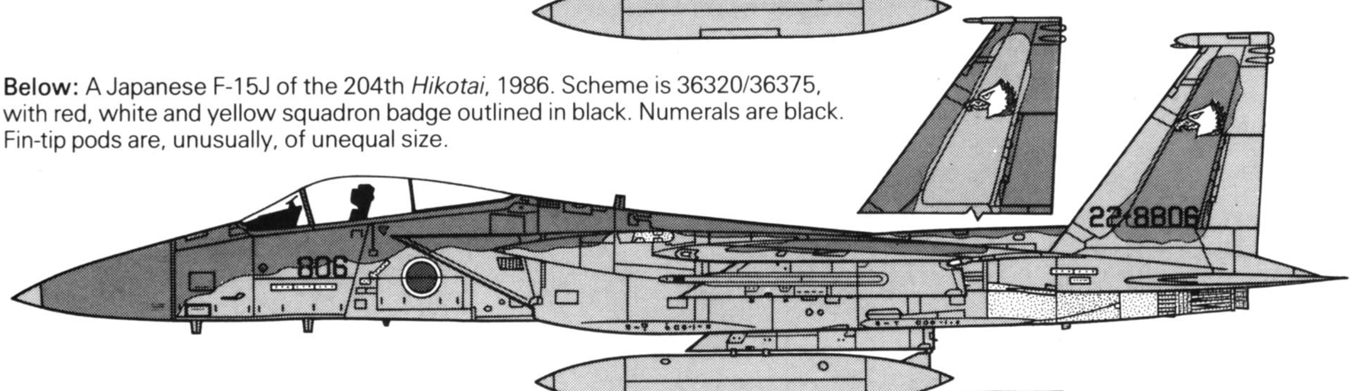


Above: A pair of F-15As from the 36th TFW. A number of different 'eagle' designs have been carried on the inboard surfaces of the fins by various F-15 units.
McDonnell Douglas

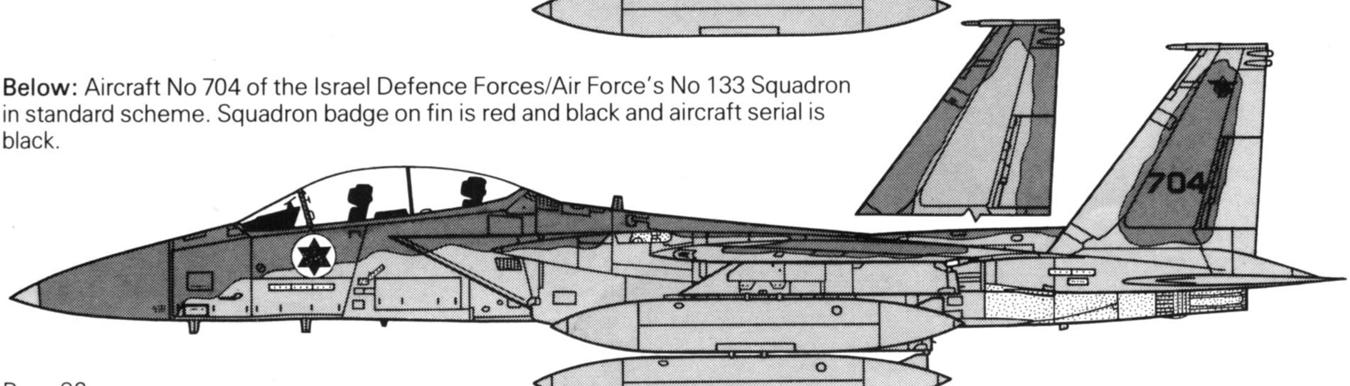
Below: F-15C 79-0027 of the 32nd TFS, with orange and black tail trim, 1986. This Netherlands-based aircraft retains the red, white and blue national markings.



Below: A Japanese F-15J of the 204th *Hikotai*, 1986. Scheme is 36320/36375, with red, white and yellow squadron badge outlined in black. Numerals are black. Fin-tip pods are, unusually, of unequal size.



Below: Aircraft No 704 of the Israel Defence Forces/Air Force's No 133 Squadron in standard scheme. Squadron badge on fin is red and black and aircraft serial is black.



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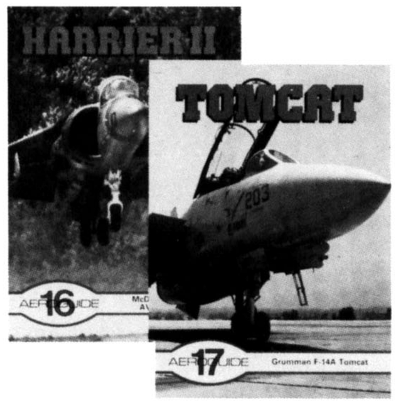

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